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JUNE 1953

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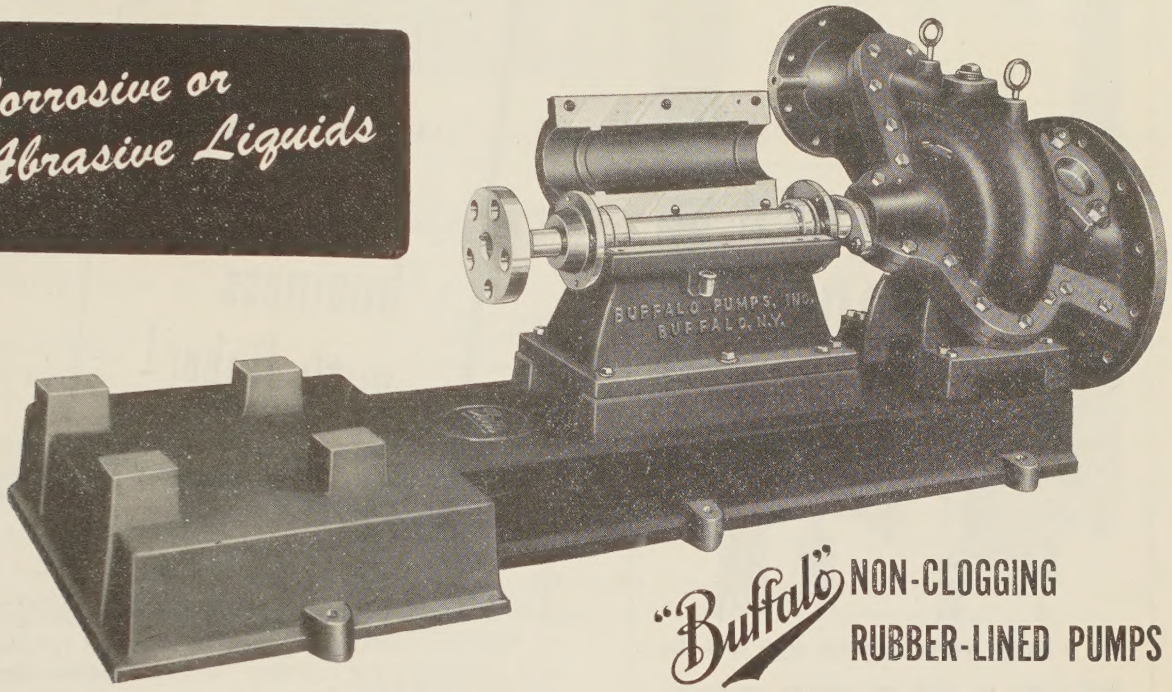

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All interior parts of these rugged pumps which come in contact with liquids are lined with hard or medium rubber, depending on the liquid. This means added years of service on such severely corrosive liquids as chlorinated solution and hydrochloric acid—as well as those containing highly abrasive solids.

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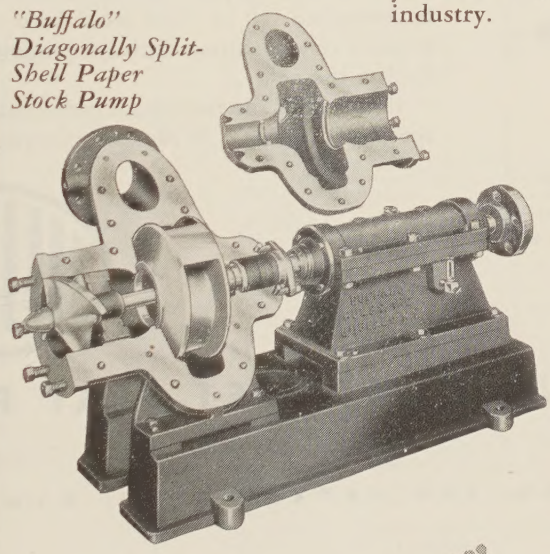

This "Buffalo" Diagonally Split-Shell Single Suction Pump with inlet booster screw is giving highly satisfactory service on high consistency stock with low submergence, in mills all over the country. Non-clogging enclosed impeller does not depend on close running tolerances for its high efficiency—therefore has no tendency to wedge and wear and finally lose efficiency. Note how upper half of pump casing is removable for quick access to impeller and stuffing box. For the best solution to your pumping problem, have us mail you Bulletin 953, with information on the entire "Buffalo" Line.

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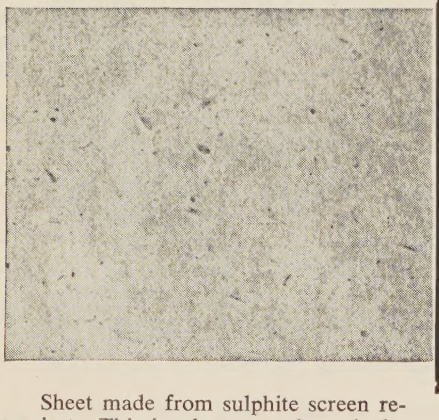
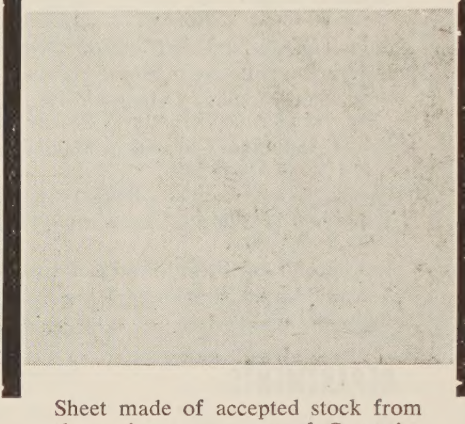
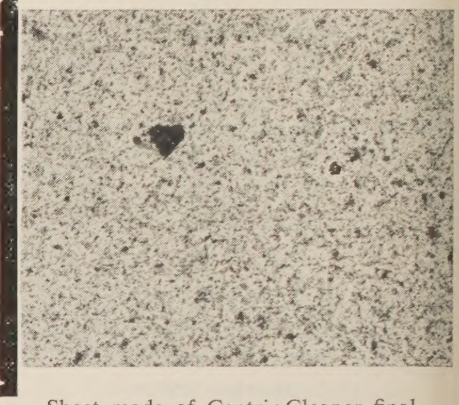
In the meantime, we suggest that you ask for our Bulletin No. P-4 which explains the construction and operation of Centri • Cleaners.



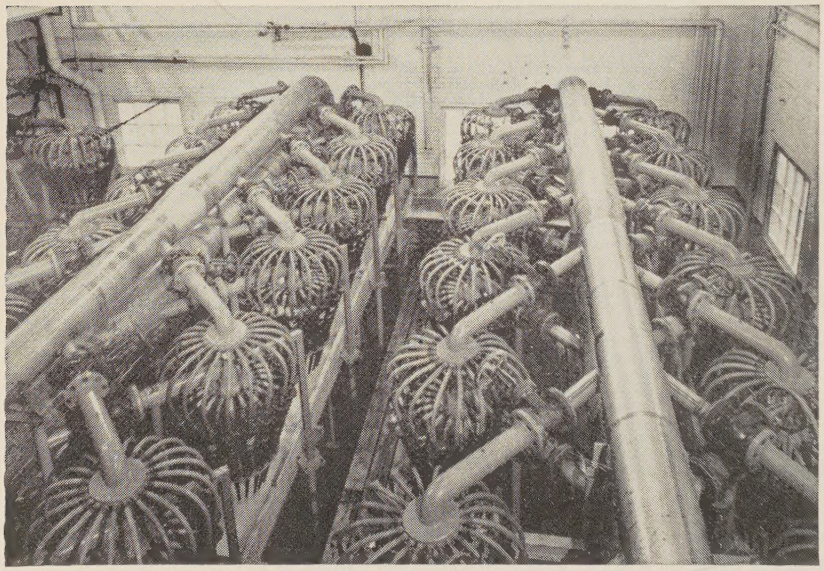
Sheet made from sulphite screen rejects. This is what went through the Centri • Cleaners.



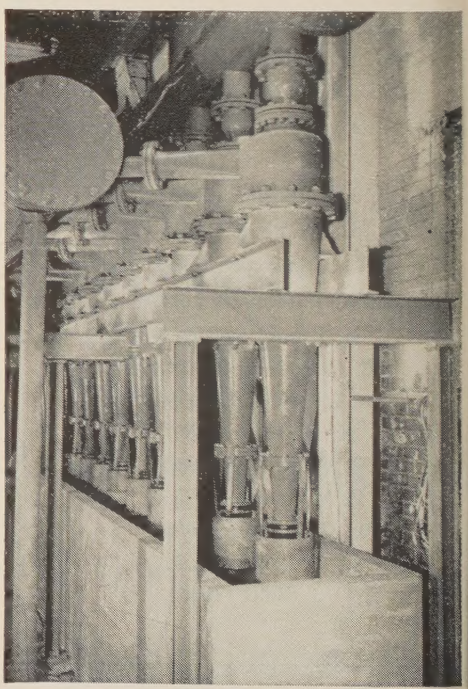
Sheet made of accepted stock from the primary group of Centri • Cleaners.



Sheet made of Centri • Cleaner final rejects. This sheet consists of sand, bark, shives, and other refuse.



Overhead view of No. 600-3″ Centri • Cleaners manifolded into inlet and outlet headers. These Centri • Cleaners are cleaning unbleached sulphite pulp.



Installation of ten primary and one secondary No. 622-12″x4″ Centri • Cleaner ahead of a paper machine. Each group is manifolded into inlet and outlet headers.

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Ask for Bulletin No. P-4

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PAPER—PLASTICS CONFERENCE

College of Forestry, State University of New York, Syracuse, N. Y.

Nov. 5–6, 1952

E. C. JAHN: (College of Foresty, State University of New York), Chairman of the TAPPI Plastics Committee. This Paper-Plastics Conference, as you know, is becoming an annual affair every Fall and is sponsored by the Plastics Committee of TAPPI.

The program this morning will be under the chairmanship of R. Lindenfelser of the American Cyanamid Co.

Fundamental Resin Problems

R. LINDENFELSER: This morning's program is devoted to fundamental resin problems. We have three talks this morning. The first one is by Mr. Rånby. He is professor at the University of Uppsala and has worked with Svedberg and is his pupil at present. Mr. Rånby is an authority on the ultra-centrifuge, electron microscope, and has done considerable work on macromolecules and specialized in cellulose. At present he is at Brooklyn Polytechnic Institute where he is a visiting professor for one year. I have had the pleasure of reading two of Mr. Rånby's papers and found them most interesting: "Aqueous Colloidal Solution of Cellulose Micelles, an Examination of Cellulose Derivatives in the Ultracentrifuge"; "The Physical Characteristics of Alpha, Beta, and Gamma-Cellulose."

Recent Studies on the Morphology of Cellulose Fibers and Their Significance for Fiber to Resin Bonding

B. G. RÅNBY

MOST of my introduction today will be devoted to a review of some of the recent work on the morphology and chemical composition of cellulosic fibers. I think it is important to have a model of the fibers defined and described as clearly and as definitely as it is possible, with our present knowledge, before we start—or rather, you start—discussing application of plastics to the fibers. I will only bring some few general remarks to this latter subject.

It is hardly necessary for me to describe the morphology of wood and wood fibers according to already known classical investigations. Such reviews are given in textbooks, the most recent by Brown, Forsaith, and Harlow in "Wood Chemistry" edited by Wise and Jahn and published this year. I think it is enough if I recall that the main part, by weight, of softwood pulps are tracheid cells with a length of 3 to 5 mm., a diameter of 0.03 to 0.05 mm., and a cell wall thickness not greater than 0.01 mm. The other constituents are the very short and thin ray cells, running both in a radial and longitudinal direction, and in some species the epithelial cells, too. Both contain large quantities of native resins. The ray cells are generally screened out of chemical pulps.

B. G. RÅNBY, Polytechnic Institute, Brooklyn 2, N. Y. on leave from the Institute of Physical Chemistry, University of Uppsala, Sweden.

In hardwoods there are several different kinds of cells—all of them generally shorter and containing thinner cell walls than the softwood cells. The hardwood fibers corresponding to the softwood tracheids are the tracheidic and the libriform cells. They form the main weight of the hardwood. The hardwood vessel cells are very conspicuous structure elements often forming thick tubes of a peculiar construction.

Much information is available on the over-all chemical composition of wood—I mean the amount of cellulose and other carbohydrates, lignin, native resins, etc. But it is well realized now that such data are by far not sufficient. It is extremely important to know also the location and distribution of these components in the cell wall. This is a very complicated analytical problem mainly for two obvious reasons: (1) the cells, that is the fibers, are very tiny structures and the cell walls are generally not thicker than about 0.01 mm., in fact most often thinner; and (2) the main cell wall constituents are complicated macromolecular compounds and we still have only an incomplete knowledge of the chemical constitution and properties of some of them. That is true, for instance, of the hemicellulose and the lignin.

In spite of these difficulties, information has gradually been accumulated from microscopic investigations performed by Ritter, Harlow, Bailey, Kerr, Lüdtke, Preston, Dolmetsch, and others. From all this work it has been concluded that a wood fiber wall has a thin outer layer, the primary wall identical with the cell wall of the original living cell. The primary wall contains a high amount of lignin, about 50%, and a lot of hemicellulose, and smaller amounts of cellulose deposited in a fairly disordered way. The fibers have a thicker inner layer, the secondary wall, which usually appears as subdivided into three layers: a thin outer, a thick middle, and a thin inner layer. The orientation of cellulose is different in the three layers. The main component in the secondary wall is cellulose. The lignin content is the highest in the outer layer and decreases gradually toward the lumen. The middle lamella, the layer between the cells, has a very high lignin content. As much as 70% is found in the compound middle lamella which comprises both the true middle lamella and the primary walls of the two adjacent cells. The residue is hemicellulose and polyuronides.

To obtain further information about the cell wall composition, attempts have been made to isolate cell wall fragments, for instance fragments of the resistant primary wall, for analysis. Such a technique is useful in some cases but I don't think it is a good general method. Optical methods, especially including specific light absorption, seem to be far more generally applicable.

I will now recall the very promising approach of Lange at the Swedish Forest Products Research Laboratory. You may have seen publications on it. Some years ago he applied microscopy in ultraviolet light for an estimation of the amount and the location of aromatic compounds, which means mainly the lignin, in thin sections of wood tissue and pulp fibers. He used monocromatic, ultraviolet light with a wavelength 2800 A, where the aromatic compounds have a very high absorption and carbohydrates practically no absorption

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This method has been developed and earlier used for biological and medical research. It is very fortunate that aromatic compounds in the cell nucleus absorb much more ultraviolet light than the other components of the living cell. Ultraviolet absorption is, then, very useful in following the growth and subdivision of the nucleus in the cells.

To demonstrate the application of this method to our cellulose problems, I refer to one of Lange's ultraviolet micrographs of a thin section of spruce wood.

We see here a section which is cut at right angles to the trunk. We see how the lignin is, to a large extent, concentrated in the compound middle lamella and we have little absorption in the secondary wall. This is nice confirmation of the earlier work of Bailey and Harlow, who used optical microscopy of wood sections stained by different dyestuffs. Lange has also measured the distribution of lignin photometrically. Here is a cell and we see here a graph of the absorption. You have the strongest absorption in the middle lamella. This is for original wood and this is for partly delignified wood chips. You see that the lignin content decreases rapidly during the delignification in sulphite cooking: (a) is the absorption curve for the original spruce wood and (b) is that after fair amount of the lignin is removed. It was concluded from this investigation that the removal of the lignin in sulphite cooking starts from the middle lamella and not from the lumen.

Lange has also recently published a similar investigation of the distribution of carboxyl groups in the cell wall of cotton and holocelluloses using visible light. To get a specific absorption, Lange reacted the carboxyl groups with the leuko-base of crystal violet and used the colored compound formed to measure the carboxyl groups.

$$[(CH_3)_2N—C_6H_4]_3—C—OH\ H—OOC—\text{cellulose}$$

This dyestuff reacts more specifically with COOH—groups than methylene blue which is also used for COOH analysis. In the reaction you get a condensation with elimination of water as shown in the formula.

Fiber cross sections were made by a microtome and photographed at 5900 A which is very close to maximal absorption for the colored compound. The distribution of the carboxyl groups is then estimated from the photometer curves of the micrographs as we see from the diagrams here.

The first diagram shows the relative distribution of carboxyl groups in the cell wall of American standard cotton. Each curve refers to a photometer curve across one cell wall. We see that the carboxyl groups are concentrated to the outer layer of the cell wall. Corresponding curves for chlorite holocellulose from birch and from spruce show that in this case, too, the amount of carboxyl groups is highest in the outer layer and then decreases approximately linearly toward the lumen. Other details of the curves are probably insignificant. The carboxyl groups are mainly attached to the hemicellulose. By gradually extracting the hemicellulose and measuring the distribution of the carboxyl groups at the same time, a lot of most interesting information could be obtained.

I have described these investigations fairly in detail because I think the methods will be important for other problems too—for instance, for studying the penetration of resins into fibers. Some resins have a specific light absorption—that is true of all resins with aromatic groups; and it might be possible to stain other resins when deposited in the fibers.

We must remember that there is one severe disadvantage in this technique and that is the low resolving power. We can't get lower than about one half of a micron and that is not very satisfactory because the fiber walls are generally not thicker than 2 to 10 mu (1 mu = 10^{-3} mm).

To obtain higher resolution the electron microscope has now been used for about 10 years. Because of the difficulties in preparing the specimens, however, its application for fiber research has not been successful until the last 4 or 5 years. As you know, a fiber wall is by far too thick to be penetrated by the electron beam of a conventional electron microscope. It is necessary to bring down the specimen thickness to 0.1 mu It is desirable to have it even thinner to secure good penetration. Furthermore, it is generally not possible to observe these thin fiber specimens without applying a metal shadow in order to increase the contrast.

Principally two methods have been used to prepare the specimens: (1) cutting proper sections of the material; and (2) disintegrating the fibers into fragments by mechanical treatment.

The first method, the sectioning, certainly represents the most straightforward approach but is the more difficult of the two. Hodge and Wardop working in Melbourne, Australia, cut a plane surface of the wood tissue, covered the surface with a thin layer of form-var (a polyvinyl polymer), applied a metal shadow at an inclined angle on the form-var layer, removed the wood by swelling it, and investigated this replica in the electron microscope. They have published their work in the *Australian Journal of Scientific Research.*

They could observe then, how the wood was constructed with a framework of thin cellulose strings, 50 to 100 A in diameter, partly embedded in an apparently amorphous substance, especially in the compound middle lamella. Hodge and Wardrop could also confirm that the cellulose strings were disordered in the primary wall, and more parallel in the secondary wall. The replica technique, however, does not give the highest resolution. Attempts have been made to study the sections directly in the electron microscope. The first problem is to bring down the thickness of the section for direct observation to about 0.1 instead of 1 mu and more. To perform the sectioning properly without disarranging the material, it was necessary to soak the wood tissue or the fibers in a mixture of monomers which could be polymerized inside the tissue to form a fairly rigid but not too hard structure. Then this reinforced fiber was sectioned in a microtome by glass knives. They were cut under water and to get the proper thickness it was necessary to bring the specimen forward by gentle cooling and heating—not just by moving it. This is a very delicate operation and, if you are very clever and very lucky, you may obtain an excellent specimen, or section. The sections are brought on a specimen holder with a membrane and the polymer dissolved away by a proper solvent, for instance, acetone.

Using this method, Mühlethaler, working in Wyckoff's laboratory in Washington, has studied the morphology of bast fibers such as flax and hemp. This work was reported at the International meeting held in New York last Fall.

Ribi, working for a time in our Institute at Uppsala, studied wood tissue. Ribi is now in this country. I have heard lectures and seen the electron micrographs and I was amazed at the detailed information on the morphology of the fibers he could give. You could see how the cellulose strings were organized to layers, going as spirals around the fiber axis; how they were embedded in the lignin in the outer layer of the cell walls. I have no slides of such micrographs but I heard the work will soon be published in *Experimental Cell Research.* I think this method, although very elaborate, will be useful in defining the basic concepts of the morphology of the fibers. It gives you a very detailed insight into the construction of the fiber.

Until now, most of the electron microscopy of cellulose fibers has been performed with fiber fragments obtained by disintegrating the fibers in water suspension by technical beating, treatment in a Waring blendor, or by ultrasonic waves. The electron micrographs have proved very definitely that the cellulose is microfibrillar all through. No membranes have been observed in pure cellulose. The cellulose framework seems to contain fairly well-defined strings

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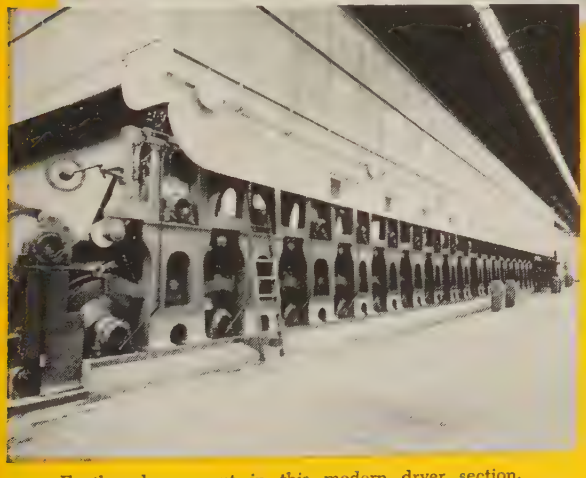
Dryer section for kraft fourdrinier liner board machine with high pressure dryers. Note also arrangement of large dryers between the calender stacks.



Footboards are out in this modern dryer section. Ladders on tracks run the entire length of the dryers.

Inefficient dryers are slowing production, increasing maintenance costs in many mills. Sometimes the replacement of outmoded low pressure dryers is the answer. In several unique modernizations, the machines continued to turn out paper by isolating each of the dryer sections in turn while the maintenance and operating crews made the change-over.

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which look very similar when isolated from pure wood or cotton cellulose.

In this slide we see a sulphite pulp from Swedish spruce, hot alkali refined and bleached, disintegrated in water suspension by ultrasonic waves, then prepared on a membrane and covered by a metal shadow.

In this specimen only some few of the cellulose strings are free, but most of them are in regular bundles. We call them lamellas, and they contain one or more layer of fairly parallel strings. In this slide you see a similar picture of the cotton cellulose. The cellulose strings look very similar. They are somewhat more regularly arranged in lamellas and we can look at the following slide which shows the measurements of the width of the strings. By using a microcomparator directly on the plates, you could fairly accurately get those measurements. We get an average width of 75 to 80 A for the wood and about 90 A for the cotton cellulose. This is a difficult measurement and we must be very cautious, because the resolving power is not better than 30 A and the measurements might be influenced by the shadow, too. A difference in width is made probable but not proved by these measurements. I don't think we would make a great mistake saying that the strings are not far from 100 A and that they contain 200 or 250 cellulose chains in their cross section.

I cannot discuss more in detail the properties of the cellulose strings, their crystallinity, accessibility to chemical reactions, etc. I would just like to point out that the cellulose strings seem to react with swelling agents like sodium hydroxide solutions in a very regular way. You know that if you immerse wood cellulose fibers into caustic soda of increasing concentration, you extract out an increasing amount of hemicellulose. At a certain concentration, the cellulose starts swelling under the formation of alkali cellulose. This reaction is irreversible at room temperature. When you wash out the alkali with water, the cellulose is transformed into mercerized cellulose which has another crystalline lattice, a higher adsorption of water or dyestuffs, and other mechanical properties than the native cellulose. We can follow the mercerization reaction in these diagrams with the x-ray diffraction pattern and the water sorption versus the NaOH concentration. We see that the penetration of the caustic soda does not start before a certain sodium hydroxide concentration—around 5% for the wood cellulose and about 7% for the cotton cellulose and still higher for the animal cellulose which is isolated from tunicates (primitive sea animals). This difference between wood and cotton cellulose is not an effect of the fiber structure or the degree of polymerization of the cellulose, because cellulose particles, micelles, isolated from the samples after a severe hydrolysis with strong mineral acid, maintain the same properties as the original celluloses. The mercerization of the cellulose particles was followed by electron diffraction.

In the electron micrographs we saw recently, most of the cellulose strings were aggregated to bundles which were not disintegrated by the ultrasonic treatment, and we could ask whether the strings are held together by cellulose chains going across from one string to the next string. Such chains could very well exist according to the fringe micelle hypothesis. It is striking, however, how easily pulp fibers containing hemicellulose are disintegrated by ultrasonic treatment.

If we look at the next slide which is disintegrated holocellulose fibers treated a short time, only 5 min., we see most of the substance appearing as free cellulose strings with a few aggregates out here. If we go on with the ultrasonic treatment—this is after 2 hr.—we see the aggregates disappear and practically only free cellulose strings all through are left.

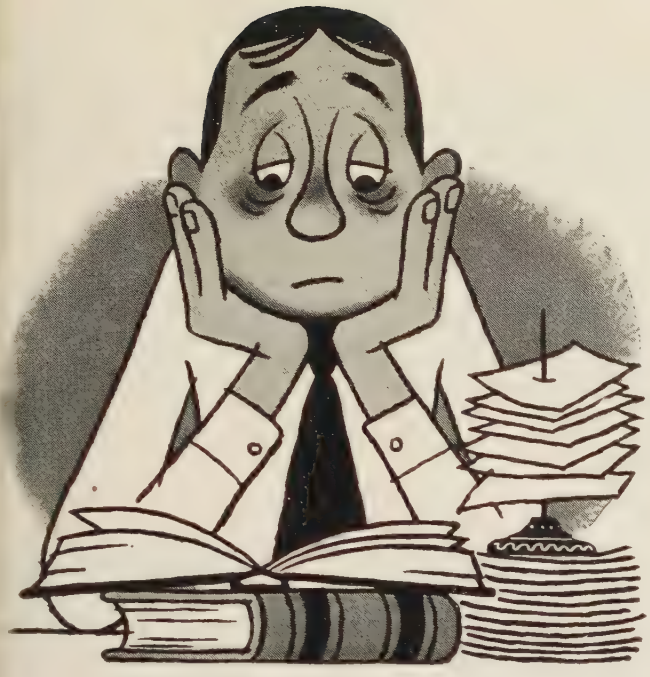
The same is true for paper pulps, especially sulphite pulps containing large quantities of hemicellulose. It seems unlikely that cross cellulose chains, if they existed, could be broken so easily by the mechanical treatment. The hemicelluloses are adsorbed on the strings so hard that it is impossible to wash them out by water. But, once removed, for instance by caustic soda, they are actually water soluble to a large extent. The ultrasonic treatment gradually sets part of the hemicelluloses free. We see them on this micrograph as coagulated amorphous lumps, easily distinguished from the cellulose strings. Even inside such a lump of hemicellulose, we can observe the cellulose strings. Such strings have never been observed in hemicellulose isolated by extraction. The alpha-cellulose contains only strings and the beta-cellulose is a mixture of particles and short string fragments. Chemically it is a polyglucose and it has the same crystalline lattice as the alpha-cellulose. It is nothing but depolymerized cellulose. All this supports the assumption that the cellulose strings form a pure phase embedded in hemicellulose. Here we have for comparison a corresponding micrograph of a purified (hot refined) sulphite pulp. In this case we obtain only a few free strings, but most of the strings hold together fairly strongly because the hemicellulose is removed.

What we have seen now is a demonstration of the effect of hemicellulose on the mechanical properties of wood pulps. With hemicellulose, they are easy to disintegrate. It is well known to every papermaker that a large content of hemicellulose makes a pulp easy to beat. Principally, the treatment of fibers with ultrasonic waves is a mechanical treatment a kind of well-defined, model beating. The fibers are vibrated into pieces. I know that ultrasonics have been used to study technical pulps both in this country and in Europe but I think this is just a beginning. Ultrasonic waves are a very valuable method to study the resistance and the strength of the fiber structure, not only of native pulp fibers but also of resin-treated fibers. In combination with optical and electron microscopy, I think it is a most powerful method of fiber research.

We could ask the question why the hemicellulose has so strong an effect upon the dispersed cellulose fibers. I think it is quite interesting to see what structures they have according to the chemical work now going on quite extensively. I have gone through the literature and it is striking how the pentosans from many different plants follow very regular and simple structure patterns.

The main chains contain anhydro-pyranose D-xylose units linked together by beta-1,4-glycosidic bonds, which means that they are identical to cellulose chains from which the 6th carbinol groups have been removed. The side chains of these pentosans are short and they contain only L-arabinose and a glycuronic acid, either one of these units or both. Generaliy one side chain is found for each segment of 5 to 20 xylose units, according to investigations of xylans from English oak, cotton seed, corn cob, wheat straw, and alfalfa hay. It is reasonable that the main xylan chains are strongly adsorbed on the cellulose strings because they fit well to the cellulose lattice. The protruding short side chains, however, cannot fit into the cellulose lattice, they adsorb water (especially their carboxyl groups) and form the hydrophilic part of the molecules. It is obvious that pentosans of this type have an ideal structure as a surface-active agent at the cellulose water interface. Their technical importance is well established in papermaking, and their structure pattern verified in recent work by Yundt (pentosans from barley straw and beech wood), Adams (pentosans from wheat straw) and Whistler (pentosans from corn cob).

If we now bring things together, we find that the model of a pulp fiber turns out to be fairly simple. I like to look at a fiber as a well-organized bundle of free cellulose strings on which hemicellulose is adsorbed. Lignin forms a partly penetrating outer layer, immobilizing the cellulose strings and the fibers in the wood tissue. One normal softwood tracheid contains several million cellulose strings in its cross section. The pure cellulose strings can be classified as hydrophobic from a colloid-chemical point of view—that means that the adsorption string to string is stronger than the



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adsorption of water on the strings so water cannot penetrate between the strings and separate them if the strings have come into position to fit well one to another. The hemicellulose is to a large extent adsorbed on the cellulose strings. The hemicellulose is a hydrophilic system which has a strong effect on the properties of the pulp fibers in water suspension, and is easily explained just as a colloid-chemical effect with the hemicellulose as a stabilizing or protecting colloid. It is not necessary to have any cellulose chains crossing over from one string to the next string. It is enough to assume that the forces between strings inside fibers are the same as those formed between fibers when a paper sheet is made.

According to the title of this address, I am expected to say something about fiber to resin bonding. If we accept this model of a pulp fiber—I think it is reasonable with the experiments we have now—it is immediately clear that resins might be applied to the fibers in many different ways.

The pulp fibers themselves are flexible in their properties. The pulping processes imply a gradual removal of lignin which is an organophilic compound with the properties of a thermoplastic phenolic resin itself. Hydrophilic hemicellulose that lies close to the cellulose strings is also gradually removed.

The fiber surfaces have a negative electric charge in water suspension. That was early observed in dyeing cellulose fibers. The charge effects in pulp suspensions have been studied further by Mason in Canada. The negative electric charge is maintained whether lignin and hemicellulose are present or not at the cellulose-water interphase. Basic organic compounds and multivalent positive ions can make the charge less negative and even make the fibers positively charged. It is then possible to have both positive and negative resin particles adsorbed on the fibers. Large particles cannot penetrate into the fiber walls and a subsequent curing under pressure will preferentially give fiber-to-fiber bonding. If a polymer is formed inside the fiber—or if we introduce a liquid polymer or a polymer in solution—we could really transform the pulp fibers into a completely new papermaking material. We could make the fibers rigid and more crease-resistant; we could make them nonwettable with water; and give them other properties as well. Such fiber materials have already been produced.

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Chairman Lindenfelser: Our next speaker is R. T. Dean who is with the Interchemical Corp. He has had wide experience in research on resins and the development of resins and their applications. He has been associated with Glenn L. Martin and Shell Development. He is a graduate of Lehigh University and received his doctorate at Yale. The subject of his paper is "Polyester Resins and Paper Laminates."

Polyester Resins

R. T. DEAN

Polyester resins were invented in the middle 1930's but were not used commercially until World War II, when they found important applications in combination with glass fibers for the armed forces, particularly the Air Corps. Following the war, civilian applications have been developed and the annual consumption has reached an estimated 20,000,000 lb. for 1952.

These materials are thermosetting vinyl resins. The curing reaction is the copolymerization of styrene monomer with maleic ester groups in polyester chains which is initiated with free radical-generating catalysts and is inhibited with conventional materials of the hydroquinone type. Gelation occurs at a low degree of reaction and most of the curing takes place in the gelled state. A vigorous exothermic reaction ensues with a rapid rise in temperature, typical of some "runaway" type polymerizations. Conventional methods for investigating the reaction kinetics cannot be applied and little is known of the exact structure of the cured materials. By analogy with more thoroughly studied systems, however, some suggestions as to probable structure can be drawn.

There are 15 to 20 peroxide-type catalysts available today for use with polyester resins. Proper selection is extremely important to the end-product fabricator. Activators have been found which are effective additives to the catalyst systems for development of desirable curing characteristics. They are not uniformly reactive with the various types of peroxides and some activators will be extremely effective with one class and almost inert with another. At least three general types are known: (1) amines, (2) mercaptans, and (3) metal salts. Data are presented on the behavior of examples of (1) and (2) with several peroxides.

Polyesters in combination with glass fibers are finding widespread commercial usage as a result of the unusual combination of the following considerations: (1) great strength per unit weight; (2) excellent physical properties; (3) good resistance to solvents, chemicals, and outdoor exposure; (4) no limitations on size or shape of objects which can be produced; (5) low maintenance of finished goods; (6) comparative ease of molding; (7) ready availability of raw materials; and (8) unlimited color possibilities.

One application of polyester resins of interest to the paper industry is the preparation of decorative and industrial based laminates.

Publication of the complete text of this paper is scheduled for the Summer, 1953, issue of *Interchemical Review.*

Question: What happens if you add divinyls instead of styrene?

Mr. Dean: You get more cross-linking. I don't know what change in physical properties you obtain. We have added small amounts of divinyl benzene and didn't notice much difference.

Question: It has been indicated that the polymerization was destroyed around 90°C. Do you have any information what type inhibitor was used at the different levels?

Mr. Dean: I don't think that is a problem. It is not the problem of the inhibitor but the catalyst. The inhibitor is destroyed when the free radicals form, when the catalyst decomposes. Benzoyl peroxide has reasonable decomposition at 80. If it is not decomposed at those temperatures, you would have a longer period. So it is not the choice of the inhibitor but the catalyst.

Question: The inhibitor gives storage life. Is that right? And, if you wanted to store at higher temperature, you would use a different catalyst?

Mr. Dean: You wouldn't keep these resins at 80° regardless of what catalyst you used. That is a problem we have never had.

Question: What is the top heat limit polyester laminates would stand?

Mr. Dean: I don't know. I should, but in connection with heat stability, I think worth mentioning is the recent development of other monomers in place of all styrene. You get a marked increase in stability and can maintain 500°F. for 24 hr. and 300°F. for 200 hr.

Russell T. Dean, Research Laboratories, Interchemical Corp., New York, N. Y.

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Question: Is it at all possible to get a completely color-free polyester resin?

Mr. Dean: You can, with extreme care, obtain products that approach it to the untrained eye.

Question: You mentioned that you have to increase the thickness of the resin to increase abrasion resistance. Would that decrease the transparency correspondingly?

Mr. Dean: You'd never notice it. These resins are essentially water white.

Mr. Mark: May I ask a question of Mr. Rånby? This problem has long been in the minds of paper chemists: Is there, or is there not, a chemical bond between the lignin and the cellulose? What I want to ask is: on the basis of recent research and more detailed studies of the morphology of the wood fiber, is there any new evidence in favor or against it?

Mr. Rånby: This problem is not solved. Recent work on the location of the cell wall components has made cellulose-lignin bonds less probable. Bonds between hemicellulose and lignin might exist—these components are concentrated mainly in the outer layers of the cell wall—and such complex molecules have actually been reported as isolated by some investigators.

Mr. Lindenfelser: For the benefit of those who came late, we did not finish this morning's program. The third speaker of the morning will deliver his talk now and then the meeting will be turned over to the chairmanship of Russell Dean for the afternoon program.

Our third speaker is Professor of Organic Chemistry at Brooklyn Polytechnic Institute. He is Director of the Institute of Polymer Science. I am sure he is well known to all of you and I could not say anything that would add to his fame and to his many accomplishments and activities, so I will turn the meeting over to Mr. Mark!

Some Recent Progress in Measuring Adhesion of Films to Metal Plates

H. F. MARK

The method briefly described here was developed by K. Wolf and his collaborators in the Physics Research Laboratory of the Badische Anilin and Soda Fabrik in Ludwigshafen on Rhine in Germany; it has been reported at various scientific meetings during the last few months and will presumably be published soon in the *Zeitschrift für Technische Physik.* It aims to measure the adhesion of plastic and rubbery films on metals or other rigid base materials, such as glass or wood.

The instrument used is a modification of similar apparatus previously employed, such as the Adherometers of the Interchemical Corp. and the National Bureau of Standards; it consists essentially of a precision lathe on which a firmly mounted table can be moved with the aid of a long screw against an equally firmly mounted scraper. The motion of the plate is very uniform; by a set of electrically driven gears it is possible to apply several velocities in the range between 10^{-3} to 1 cm. per sec. The scraper consists of a knife which is fixed on a heavy beam and which can be adjusted in the vertical direction with a precision micrometer screw. It is connected with a strain gage so that the force exerted by it during the scraping off of a film can be measured accurately and can also easily be recorded.

The procedure to measure adhesion of a film on a base plate is the following: the film is painted or cast on the base plate in such a manner that it forms a rectangular strip of about 1 cm. width and 5 to 6 cm. length. The plate is then firmly connected with the moving table and the knife is adjusted in such a manner that its blade just slightly touches the surface of the base plate. The plate is then electrically displaced for about 1 to $1^1/_2$ cm. in such a way that the knife shaves the plate without reaching the area which is covered by the film. During this motion of the blade the accuracy of the adjustment is checked; if the blade is too high above the plate (more than 2 to 3 mu) then the resistance offered to the blade is insignificantly small and the film would be *cut* by the blade rather than *scraped off;* one would measure the *cohesion* of the film rather than its *adhesion* to the plate. If the blade is adjusted too low, then it scrapes off a substantial amount of the metal surface, experiences a very large resistance, and cuts the base plate instead of scraping off the film. The proper adjustment of the height of the blade is a matter of experimental skill and of the precise functioning of the instrument. Extensive blank runs and microscopic and interferometric study of "shaved" plates indicate that it is possible to adjust the knife blade in such a manner that essentially all of the film is removed without scraping off any substantial amount of metal. It appears that adjustments between 0.3 and 0.6 mu above a well-polished plate give acceptable results.

After a sufficient number of preliminary blank tests, the blade is now placed in the immediate neighborhood of the film and after a short run over a part of the uncoated plate, hits the film and scrapes it off. As soon as the boundary of the film is reached the force registered by the blade increases sharply and maintains an essentially constant value while the film is removed. The blade is wider than the film strip and, hence, the total force registered by the strain gage is the sum of the force necessary to overcome adhesion and the force necessary to deform the film plastically.

This experiment is then repeated with films of four or five different thicknesses and the total resistance offered to the blade is plotted versus the thickness of the film. It was found by Wolf and his co-workers that the points of such a plot are arranged on a smooth line with a very slight upward curvature. This makes it possible to extrapolate this relationship to zero thickness and to interpret the results of such a measurement in the following manner: (1) the intercept at the ordinate represents the force necessary to overcome the adhesion of the film to the base plate; it is taken as a measure for *adhesion* and (2) the slope represents the force necessary to deform the film and is taken as a measure for the toughness of the film.

This method has found widespread application in the investigation of many plastic films, such as vinylites, polyethylene, Saran, nylon and polyesters to steel, aluminum, and brass; it is particularly useful to study the action of certain additives in their capacity as plasticizers and tackifiers and makes it also possible to explore the aging of films under certain conditions such as light, heat, and exposure to chemical attack.

Mr. Lindenfelser: How difficult is it to set up the film? It strikes me that, since the portions being measured are relatively small, very fine control would be necessary to obtain the data which could be interpreted significantly.

Mr. Mark: That is perfectly correct. I think the real achievement of this group is that they have developed a scheme of doing that. I have the impression that they lay down a film five times and get essentially the same thing.

Question: Does the knife shear the film?

Mr. Mark: They do it both ways. By looking at the plate which has been scraped, you can see whether patches have been left and then you can deliberately make an experiment where the film itself is shaved.

Question: That is measuring cohesion?

Mr. Mark: That is right, and they compared their experiments with the creep curve and from that you get viscosity if you want to extrapolate it.

Question: Just what effect does the speed of the chisel or knife have on that?

Mr. Mark: They have investigated quite a range of speeds and the situation is this: if you plot slope against the speed, first use a very slow motion, a millimeter in 1 min. and then something visible, maybe a millimeter a second, and plot the slope, which is plasticity, against the rate. They obtained a normal Bingham curve and they compared that with the creep curve. They obtained a reasonable agreement, not as far as figures, but in order of magnitude. They also measured the influence of temperature and compared that with the creep curve.

Question: The Bureau of Standards recently had a note published about an instrument for the measurement of adhesion where they removed the film with inertia and vibrated the bar at various frequencies.

H. F. Mark, Director, Institute of Polymer Research, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

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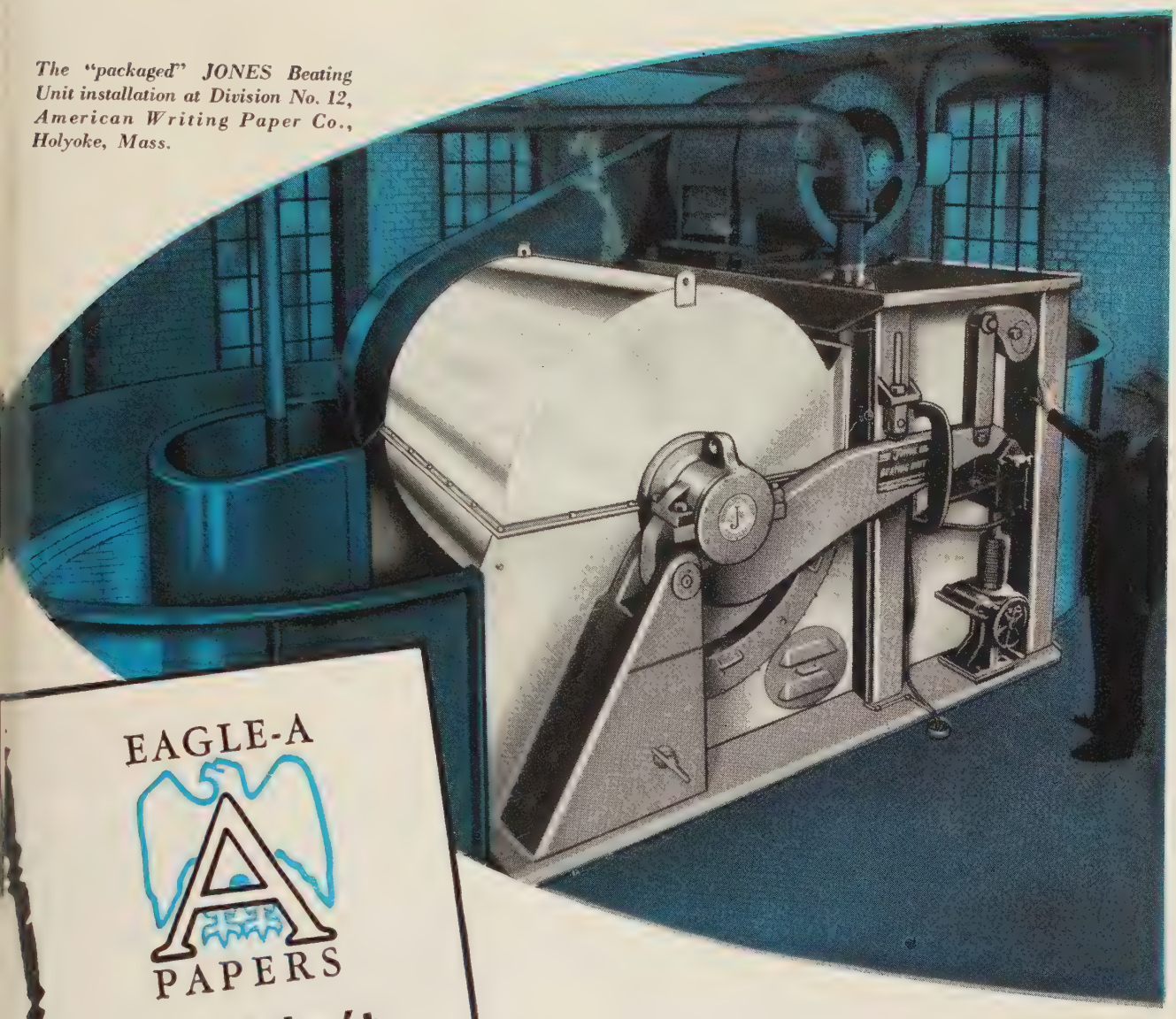

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Mr. Mark: They actually centrifuge the film off. It would be interesting to select cases whereby similar materials have been used and compare them.

Chairman: The Bureau of Standards have tested the same materials on both methods. They did not get an exact correlation but there is a general correlation. Therefore, in arranging things in order of adhesion one or two papers might be different. The report was in the Paint and Varnish Division of ACS and I believe they have a complete transcript available.

Special Resin Systems

CHAIRMAN R. T. DEAN: The first paper will be given by A. J. Barry. Art graduated in 1932 from the Syracuse College of Forestry and received his Ph.D. in 1936. He taught organic chemistry until 1936–37 when he joined Dow Chemical Co., where he was Research Supervisor until 1947. Since then he has been Assistant Director of Research for the Dow Corning Corp.

Properties and Uses of Silicones

A. J. BARRY

THE popular name "silicones" embraces wide varieties of fluids, greases, rubbers, resins, and special compositions of diverse uses. In chemical structure they are basically organic modifications of inorganic polysilicates. This hybridization of organic and mineral chemistry in the silicones has endowed them with many unique properties and adapted them to a wide range of practical applications over broad ranges of temperatures. A few of these uses of particular interest to the paper technologist will be considered following a brief review of organosilicon chemistry and a discussion of the silicone to cellulose bond.

SILICONE CHEMISTRY

The principal raw materials are sand, salt, coal, and oil. From these the primary chemical intermediates, the organosilicon halides (such as $MeSiCl_3$, Me_2SiCl_2, Me_3SiCl, $PhSiCl_3$, etc.) are synthesized by three basic processes. The reaction of the organosilicon halides with water leads to the corresponding silanols such as $MeSi(OH)_3$, $Me_2Si(OH)_2$, $PhSi(OH)_3$. Many of these may be isolated under special techniques, but generally they avidly condense to eliminate water and form fluid, elastomeric, or resinous polymers depending on the functionality of the building units.

The fluids are linear compounds in which the molecular sizes range from a unit of two silicons and one oxygen to chains containing as many as 40,000 $-\mathrm{SiO}-$ (R) building units. The viscosity is varied accordingly. The choice of alkyl or aryl groups on the building units will determine the thermal stability of the fluid, its viscosity/temperature slope, lubricity, and various other properties. The fluids are soluble in general organic solvents of mildly polar to nonpolar character.

The resins are complex structures analogous to inorganic glasses. Their solubilities and other properties may be widely varied by: (1) the ratio of building units of the end group, chain-forming and cross-linking types, (2) the choice of substituent R-groups, (3) hydrolytic technique, (4) condensation method, (5) after treatment, (6) curing conditions, and (7) use of catalyst, etc. The resins may be made generally organocompatible in polar and nonpolar solvents: a special one showing some solubility even in methanol.

The silicone elastomers must be considered as compromises between fluids and resins, long linear structures with a mild degree of controlled cross-linking. Proper choice of R-groups in a silicone rubber will ensure flexibility at Arctic temperatures and at the same time afford prolonged operation at 250°C.

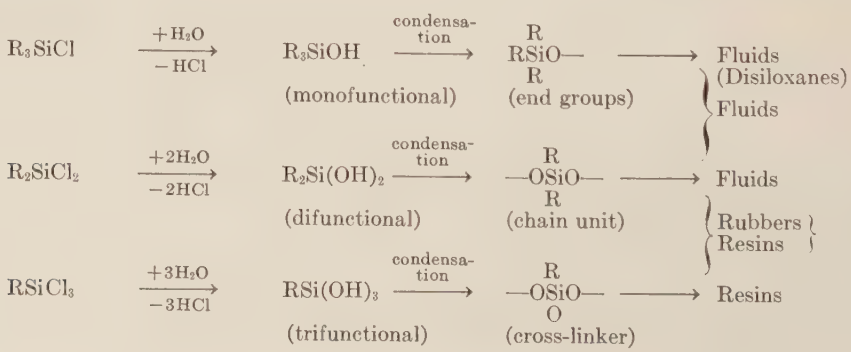
SILICONE-CELLULOSE BOND

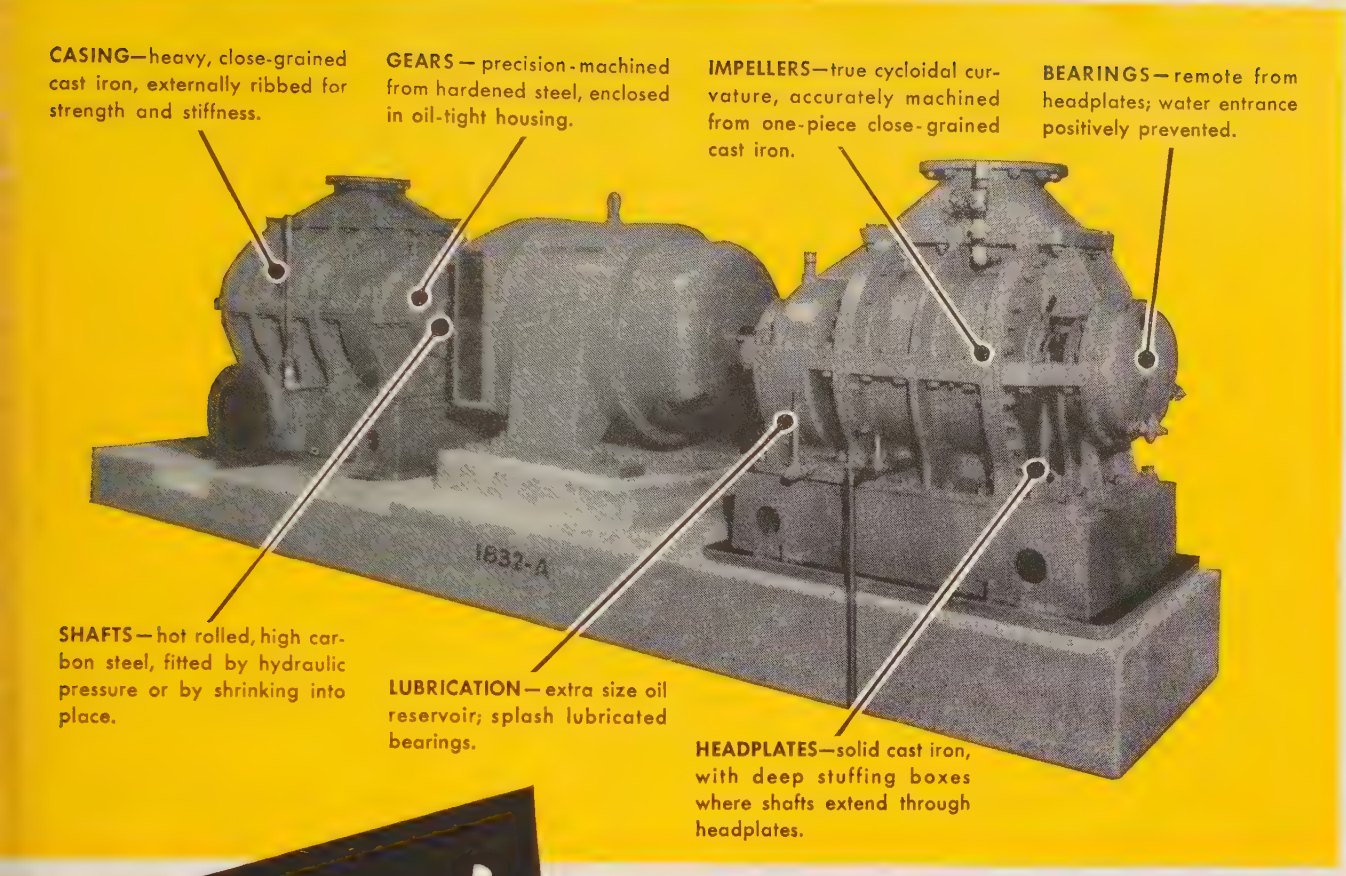
The literature shows a wide scope of interaction between organosilicon compounds and cellulose, ranging from formal chemical reaction to adsorption. The reactions of various organochlorosilanes of the type R_3SiCl with cellulosic hydroxyls in the presence of pyridine are interesting. While attempts to prepare organosoluble derivatives from native cellulose by this means have not been successful (*1*), the similar treatment of partial esters or ethers of cellulose has given completely substituted cellulose derivatives, e.g., a water-soluble methyl cellulose (1.7 MeO groups) has been converted to a benzene-soluble silicon derivative containing 1.7 MeO and 1.3 Ph_2MeSiO groups (*2*).

There are several examples of surface-limited chemical reactions whereby the cellulose properties have been altered to afford improved wet strength. The use of $EtSiCl_3$, $MeSi(OEt)_3$, $EtSi(OEt)_3$ is reported for such purpose (*3*). The reaction of compounds containing large aliphatic groups, e.g., $C_5H_{11}(C_{12}H_{25}O)_2SiOAc$, eliminates acetic acid and converts all surface hydroxyls to hydrophobic siloxy groups making the fiber highly water repellent (*4*).

Adsorption of silicone resins on cellulose fibers is finding application for the preparation of water repellent and "abhesive" papers. This is probably a function of polar orientation of the $\begin{smallmatrix}\mathrm{Si}&\mathrm{Si}\\ \diagdown&\diagup\\ \mathrm{O}&\end{smallmatrix}$ structure into the surface structure of the fiber with strong retention by hydrogen bonding. Consequent orientation of the fatty groups outward from the surface would thus account for the water repellent character so effected. The use of silicone resins in beater sizing was described in 1947 (*5*) by Bergendahl and Libby. They concluded that fast curing silicone resins were suitable and could

A. J. BARRY, Asst. Director of Research, Dow Corning Corp., Midland, Mich.

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be applied by normal beater-sizing methods. The freeness, type of pulp stock storage, and several other factors did not affect the results, but hardness of water had to be controlled and the pH held below 7.0 The small amounts of silicone resin required to give good ink resistance did not affect the tensile properties of the paper. This small size demand suggests silicone-sized papers for specialty uses such as cigarette papers and condenser papers.

The combined effects of chemical reaction and adsorption are represented in the hydrophobing of textiles and paper with Dow Corning 1107 and DeCetex 104. These treatments which are of widely diversified commercial importance involve polysiloxane structures containing Me—Si and H—Si linkages. Surface orientation and hydrogen bonding of the SiOSi chain as previously discussed play an important role. The measurable loss of silane hydrogen during the curing step suggests a direct chemical reaction to give a siloxycellulose derivative at the surface. In addition, the polysiloxane undergoes further self-polymerization in the curing.

UTILITY OF SILICONE PRODUCTS

The hydrophobing agents, Dow Corning 1107 and DeCetex 104, have been extensively used in the textile industry for the manufacture of water repellent fabrics. They are gaining popularity in the treatment of paper products not only for water repellency, but for the "abhesive" qualities simultaneously imparted to the paper (*6*). As examples of silicone treatments where water repellency alone suffices, might be mentioned tissues for air conditioning filters and papers for oil filters. Paper rainwear and disposable diaper covers are at an experimental stage of development. "Abhesive" qualities of silicone-treated papers are important in their use as backing for electrical, first-aid, and other pressure-sensitive tapes, as interleaving papers replacing the more expensive Holland cloth in the handling of plastics and rubber stocks, as packaging materials for tar and other sticky substances (*7*). Water repellent and "abhesive" qualities combined with the nontoxic nature of the treatment have adapted silicone treated papers to the lining of baking pans, as baking papers for "Brown and Serve" rolls and sweet rolls and as release papers in candy making (*8*).

The thermal stability of the polysiloxane fluids combined with their very low viscosity/temperature slope adapt them to a wide general utility: damping fluids, liquid dielectrics, instrument fluids, lubricants, hydraulic fluids, sealing compounds. They are particularly satisfying in applications where extreme changes in temperature must be met with the least change in consistency and performance. Their film spreading characteristics have placed them in most modern furniture and car polishes.

Of interest to the paper technologist these fluids are used as an impregnant to make capacitor papers, lens cleaning tissues and nonsticking tips for cigarettes (*9*). They are widely known as components of the Dow Corning greases, antifoaming agents, and mold release emulsions.

The silicone greases are used in a myriad of high-temperature applications such as the bearings and chain drives of paper waxing equipment operating at over 300°F.

The antifoaming agents are remarkable in their ability to defoam liquid mixtures when added to the extent of only 20 to 200 p.p.m. Added to the beater these agents eliminate foam and microbubbles which would otherwise cause irregularities in sheet formation and attendant imperfections in subsequent operations. When added dropwise in the headbox, foam is eliminated on the paper machine. The antifoaming agents are highly effective in rosin, starch, glue, and other sizing operations. They are used in latex, casein, and other coating operations and also in the application of adhesives. They have also been used in black liquor processing.

The mold release emulsions were originally developed and are extensively used for release of rubber tires from the vulcanizing molds. However, they are popular in a growing number of applications where the problem of efficient release has to be answered. There are many examples of their utility in the field of papermaking. Coated thinly on calender rolls, they afford clean release of the paper sheet in many cases where sticking otherwise occurs. These emulsions or a special silicone compound prevent sticking on the sealing shoe of bag machines and on heat sealing equipment. They also suppress build-up of water glass on rolls in manufacture of corrugated paper. Dow Corning mold release emulsion is also employed as an offset spray to prevent gummed labels from caking together.

The silicone resins are well recognized for their many electrical uses where high temperature conditions prevail. Dow Corning produces a number of electrical varnishes, magnet wire enamels, and impregnating resins for class H insulation in motors and other electrical equipment. Motors so insulated are desirable in the paper mill in many locations where overload and wet conditions must be met, e.g., grinder, chipper, and pump motors. Several silicone insulated motors are in service where they are badly slopped with alkalies and black liquors.

A number of silicone paint resins are on the market. In the paper plant they are used on smoke stacks, steam turbines, and ducts for hot corrosive flue gases.

Many laminating resins have been developed for glass fiber and mica laminates. These are of interest also in special papers based on glass fiber, asbestos, rock wool, or other mineral fibers.

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CHAIRMAN: The next paper is "A Melamine Type Resin for Beater Addition Process to Form Laminated Sheets or Molding Preforms." It will be given by Mr. Lindenfelser who is in the Development Division of the American Cyanamid Co. and interested particularly in the plastics work. In addition to that, he is concerned with adhesives and related products.

A New Resin for the Resin Pulp Molding Industry

R. LINDENFELSER

THE molding of resin pulp preforms has developed into an important industry. The scope of the industry has been somewhat limited, however, possibly due to the lack of a light-colored and light-stable resin suitable for decorative applications. This paper is a review of the resin pulp molding process with particular emphasis on resins and the introduction of a new resin which has light-color and light-stable characteristics. The paper is concerned primarily with preform compositions that have a sufficiently high resin content to render plastic character to the moldable preform and to provide rigid moldings with durability comparable to commercial melamine and phenolic compounds. Such compositions will contain, in general, 20 to 70% by weight of resin

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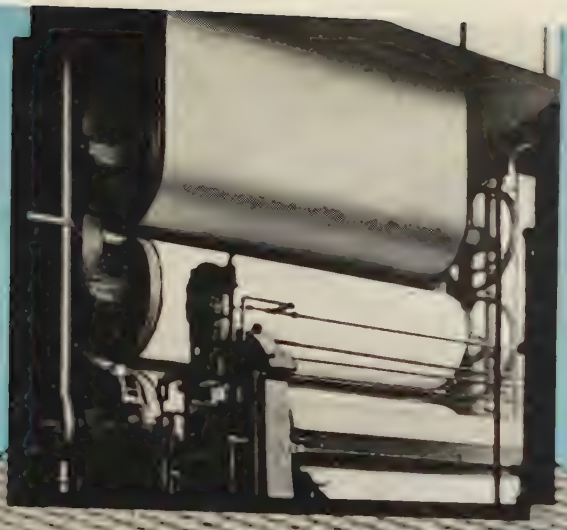

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The process of molding pulp preforms is old. It undoubtedly had its origin in the papier-mâché process. As early as 1866 and 1867 patents were issued which taught the process of molding hollow objects from dispersions of pulp in water (*1, 2*). In 1915, Baekeland suggested the idea of adding phenolic resin to obtain vastly superior durability (*3, 4*). Baekeland added an alkaline solution of phenolic resin to an aqueous pulp dispersion, precipitated the resin on the pulp, and then by conventional pulp preforming and molding techniques obtained molded objects that would withstand cold or boiling water, solvents, and most chemicals. He found these objects to be superior to rubber, celluloid, shellac compositions and, in fact, all plastics previously known.

In his patent Baekeland disclosed paperlike products which were transformable into infusible articles. He recognized the extensive possibilities of the process by stating that it was not necessary to dry his product in sheet form but that it also could be dried in bulk or in any form whatsoever; for instance, in the form of tubes or other suitable shapes. Baekeland further indicated that he could use other fibers such as asbestos, and that such fibers were desirable for certain applications such as electrical insulation.

From this early date to the present, there has been continuous literature on the subject of pulp molding. However, there has been relatively little reference to the use of resins in pulp preform molding in the patent literature prior to 1928 and relatively little periodic literature prior to 1940.

Beginning about 1940, considerable interest developed in the resin pulp preform molding process and several companies entered the field. The Ford Motor Co. experimented with the preparation of automobile bodies (*5*). They molded 14 separate panels from phenolic resin pulp dispersions and attached these panels to a welded tubular steel frame to form a lightweight experimental car. The resultant saving in weight compared to the conventional Ford car was 1000 lb. A decorative finish was obtained by painting. The Keyes Fiber Co. introduced a molded composition under the trade name of "Kysite" (*6*) and found wide acceptance for a serving tray made from it. In 1943 the same company produced molded valve hand wheels for a destroyer (*7*) and found them superior in many respects to metal. The Hawley Products Co. produced disk springs and diaphragms for communication equipment (*8*). By 1943, one company had developed a million-dollar business based on resin pulp preform molding (*9*).

The process and equipment for resin pulp preforming and molding has been described by several investigators (*10–13*), and in considerable detail by Penn (*14*). Briefly, the process consists of the preparation of a suspension of fibers in water, usually by means of a paper beater. The slurry may contain as low as 0.1% solids or, in the case of some fibers such as asbestos, as high as 10% solids (*15*). To this suspension of fibers is added resin and other ingredients such as dispersing agents, precipitants, pigments, and mold lubricants. The suspension is then formed onto perforated or screen-lined molds by vacuum or by pressure. The preforms are squeezed free of excess water and subjected to a drying operation to remove the residual water. These articles are then molded at conventional molding temperatures, pressures, and times to produce the finished article.

Resins may be incorporated by several processes, e.g., by simple dispersion of very finely ground water-insoluble resin, by addition of an emulsion, or by controlled flocculation or precipitation of solutions and emulsions (*16–19*). Many machines have been proposed for the formation of resin pulp preforms and are listed in a review by Chaplin (*20*). Alternatively the resin may be added by impregnation subsequent to the forming operation but for reasons of economy, operational simplicity, and obtaining the greatest strength in the molded article, this method is not preferred. In fact, Martin (*21*) discarded the impregnation method because of the need for solvent and numerous other practical production problems.

Resin pulp preform moldings have many advantages over metal articles, and the resin pulp preforming process has many advantages over conventional molding techniques. Parsons (*7*) has listed the advantages over metal of appearance, low weight, corrosion resistance, and heat and electrical-insulating qualities. Compared to some metals, such as aluminum, there is a further advantage in abrasion resistance. In the case of the molded valve hand wheels, Keyes Fiber (*7*) found that production time was cut 39% by substituting the plastic for metal. Several investigators (*22–25*) have enumerated the advantages of the resin pulp preform molding process over conventional molding technique. Most of these advantages are based on close reproduction of the final molded shape in the preform. As a result of this close reproduction, considerably less resin flow is necessary in order to accomplish the final molded shape and surface. The reduced flow requirement permits lower molding pressure which, of course, entails less costly equipment, less mold wear, the ability to mold larger pieces, and reduced operating costs.

Whereas conventional molding compounds are formed at pressures of upwards of 1000 p.s.i., and usually about 3000 to 4000 p.s.i., much lower pressures are reported to be possible with resin pulp preforms (*26*). Pressures of 200 to 1000 p.s.i. are not uncommon and, in fact, the Ford panels were molded at 50 p.s.i. (*5*).

A second reason accounting for the superiority of the resin pulp preforming process is the felting of the fibers on the preform. Since the preform is made to approximate closely the final molded shape, this felting action is not disturbed and the result is very high strength and shock resistance.

The strength of the molded preform varies inversely with the resin content (*22, 26*). It is always high, however, as shown by Martin (*21*) and Mosher and Griffin (*27*) and, in fact, may range up to 25 times the strength of conventional moldings as shown by Penn (*25*).

Mosher and Griffin (*27*) also have shown that the strength varies with the type of pulp. They believed this was primarily due to differences in fiber length. However, Schwartz, Pew, and Meyer (*28*) found that the nature of the wood was important. The latter investigators demonstrated that birch neutral sulphite fiber with one half the length of spruce fiber and black maple fiber with one fourth the length of spruce fiber gave toughness and tensile strength equal to the spruce fiber. Later, Penn (*14*) showed that for a particular type of pulp, fiber length was indeed important. He was able to demonstrate a considerable improvement in Izod impact strength with increased fiber length.

The resin pulp preforming operation is frequently thought to be a slow process. However, Young and Box have pointed out that the forming operation is a matter of seconds (*8*). They further showed that moldings may be made to very close tolerances and succeeded in molding several million thin diaphragms to an allowable tolerance of ±0.0002 in.

The simplicity of the process results in low cost (*12, 26*) and this is a third advantage. In comparing costs it should be kept in mind that preform moldings have the combined advantage of easy moldability, high strength, and low cost. High-impact molding compounds are commercially available but invariably the moldability of these compounds is sacrificed to achieve high strength (*10*). Young and Box (*8*) estimated in 1943 that phenolic resin preforms ready for molding could be produced at as low as 10 cents per lb.

Phenolic resins have achieved an eminent position in the resin pulp preforming process. This is quite understandable when we consider the resin requirements. Certainly, to obtain maximum efficiency in the preforming process, a resin must be water insoluble. To mold well, it must have good flow; and to mold efficiently and impart rigidity and durabil-

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ity to the molded object, it must be thermosetting. Phenolic resins have all of these properties.

Many other resins have been examined. Several investigators (*29*, *30*) have reacted aniline with formaldehyde in dilute aqueous acid solution, added pulp, and precipitated the resin on the pulp by the addition of a base. Objects molded from these compositions have excellent molded mechanical strength and electrical-insulation properties. However, the relatively stiff plastic flow of aniline resins is a disadvantage for most molding operations.

Schwartz, Pew, and Meyer (*31*) prepared moldings from lignin and pulp but found that some phenolic resin was necessary in the formulation and that the lignin moldings were inferior to phenolic resin moldings with respect to water resistance and strength.

Kenney (*32*) produced wall boards and molded articles with coumarone-indene resin, but these resins required a relatively long cure. Talbot (*33*) used natural resins such as rosin, or preferably rosin plus fatty acid pitch, and was able to burnish molded articles to an excellent finish. Groff (*34*) disclosed the use of a finely powdered vinyl resin, particularly polyvinyl chloride, to produce a moldable composition. This resin is thermoplastic, however, and as previously noted, thermoplastic resins are not readily adaptable to the molding techniques which provide a combination of high strength, low cost, and rigid, durable moldings. It should be noted that most of the resins listed are dark in color and not color stable.

In view of the many advantages offered by the resin pulp preforming process, it is difficult to see why the industry has not grown to greater size. Perhaps one fundamental reason is the color limitation of phenolics and those resins which have been adapted to the process.

Melamine-formaldehyde and urea-formaldehyde condensation products have been suggested (*11*) for resin pulp preform molding but their use entails technical difficulties. Melamine and urea resins retain considerable water solubility through the flow period of the resin. Therefore, to obtain the water insolubility which is essential for the resin pulp preforming process, it has been necessary in the past to advance the resin to a condition where the resin has relatively little flow. For this reason, melamine resins have not achieved to date much commercial importance in the pulp molding field. The problem of obtaining adequate flow with suitable water insolubility evidently existed in the early stages of phenolic resin development. Clapp (*35*) recommended Montan wax as a fluxing agent for phenolic resin. Redman and Cheetham (*36*) recommended free phenolic bodies. Where impregnation techniques are feasible, melamine or urea resins may be used to advantage (*11*, *27*, *37*).

A solution to this problem is to so alter the melamine molecule that water insolubility may be obtained without loss of plastic flow. One method of doing this is to choose a molecule having a phenyl group in place of one of the amino groups in melamine and then to formulate a special resin from this raw material. The raw material is, of course, benzoguanamine and by proper formulation, we have prepared a resin* which is eminently suited for the resin preform molding process. The resin is completely water insoluble and has good plastic flow. It has excellent color and color stability and cures readily under conventional molding conditions. Molded objects have good physical properties including good mechanical strength, water resistance, solvent resistance, and heat resistance. In fact, molded pieces have generally all of the good physical properties obtained with melamine resin.

Whereas the industry, up to the present, has been limited by the dark colors characteristic of phenolic resins, now by use of this new resin unlimited colors are possible, ranging from white to delicate pastels to rich yellows, greens, and blues. Decorative finishes for pulp moldings have been possible in the past by such techniques as baked-on finish, impregnation of preforms, and by use of overlays. None of these processes, however, have permitted the full utilization of the resin pulp preforming process. None have permitted the potential scope of operation that this new resin permits.

The use of this new resin is illustrated in the following way. A 2% slurry of pulp in water is prepared by conventional paper-beating techniques. The slurry is diluted to 0.2%, and to it is added the proper amount of benzoguanamine-formaldehyde resin, curing agent, mold lubricant, zinc sulphide pigment, and a small amount of color pigment. These ingredients are thoroughly mixed and alum is added to assist in dispersion and fixing of the resin on the fiber. The fibers and resin are then formed by sucking the slurry under vacuum onto a perforated mold. The resultant preform is dried and then molded by conventional molding techniques.

The physical properties of some typical molded preforms made with this resin are presented in Table I. The resin content of these moldings is 65%.

In the use of this resin we are mainly concerned with surface appearance; therefore, certain factors are important. It is important that a high resin content be maintained as has been shown previously by Penn (*25*). This is necessary in order to obtain a smooth finish and good surface durability, particularly with respect to water resistance. It is obvious that to prepare light-colored surfaces, very clean pulps must be used and, in fact, the purest grade of cellulose is desired. It appears desirable to have the maximum "slowness" in the pulp and to use maximum pressure in molding (*14*). These factors contribute to good resin retention and surface appearance. Additional requirements are: good resin dispersion, careful preforming to the final shape to avoid flow of the fibers, and proper cure conditions.

A further use of these resins is suggested by their good arc resistance, dielectric strength, and heat resistance. These properties should permit the formation of high-strength electrical-insulation parts where phenolic resins would be unsuited because of poor arc resistance.

The new benzoguanamine-formaldehyde resin may be used in any of the various modifications and improvements in preforming processes described in the literature. Carter (*39*, *40*) shows methods of forming homogeneous, resin-bearing, dish-shaped articles of high strength and durability. Sawyer suggests the use of alternate high resin content and low resin content preforms to attain good bonding and high strength (*41*) or the use of multiple layers of various types to obtain good surface durability with high strength (*42*) or the formation of flat sheets from which blanks may be molded to shape to achieve economy (*43*). Hollow articles with reinforced edges may be made by the method of Randall (*44*). The resins may be used in the pressure-felting processes disclosed by Hawley (*45*) and Hatton (*46*). Further, the benzoguanamine-formaldehyde resin is soluble in alcohol and may be employed in an impregnation process for special effects as suggested by Sawyer (*37*), or it may be used in combinations of soluble and insoluble resins to obtain selective impregnation as taught by Young (*47*). Selective impregnation may be desirable for surface durability and high strength. Low fabricating cost can be achieved by continuous processes, for example as disclosed by Chaplin (*48*).

The literature suggests many uses for resin pulp molded products as well as methods for making molded articles. Tableware, trays, wire-reinforced, molded tubular structures such as struts and beams (*49*), seats, various consumer articles (*33*), fiberboard (*35*), textile cones (*50*), electrical-insulating board prepared with asbestos fiber base (*15*), and filters (*51*). In addition, a vast variety of miscellaneous items has been proposed, such as safety helmets, decorative moldings, wash basins, vacuum-cleaner housings, toilet seats, switch gear and instrument cases (*21*, *25*).

* Available on an experimental basis from the Plastics Dept., American Cyanamid Co.

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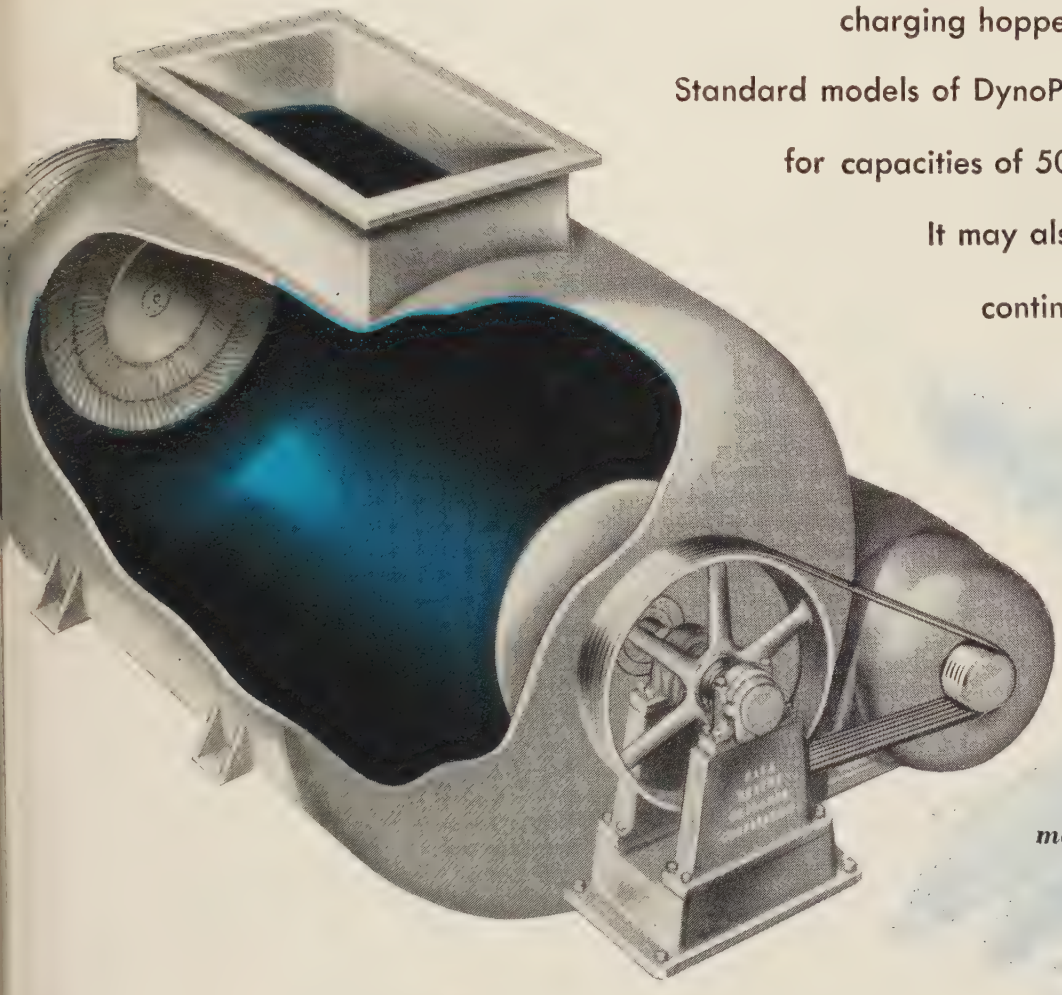

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Table I. Comparison of Benzoguanamine Resin Pulp Preforms with Commercial Molding Compounds

Test	Test method	Commercial cellulose-filled melamine resin molding compound	Experimental benzoguanamine resin pulp molding compound	Phenolic resin pulp molding compound
Resin content	.....	65–70	60	35–55
Compression molding temp., °F.	.....	310–370	310–370	310–375
Compression molding pressure, p.s.i.	.....	1500–6000	1000–3000	800–3000
Color possibilities	.....	Unlimited	Unlimited	Dark colors only
Specific gravity	D 71–27	1.5	1.5	1.33–1.40
Weight increase, 24-hr. soak, %	.....	0.1–0.4	0.8	0.4–1.5
Weight increase, 30-min. boil	.....	0.2–0.4	0.32	.....
Light stability, 50-hr. sunlamp	.....	Excellent	Excellent	Yellows
Shrinkage, mils/in.	Stamford	6–9	3.1	.....
Shrinkage after 48 hr. at 220°F., mils/in.	Stamford	8–10	2.9	.....
Flexural strength parallel,[a] p.s.i.	D 790	12,000–15,000	13,800–14,900	14,000–18,000
Flexural strength perpendicular, p.s.i.	D 790	.....	13,100	12,000–17,000
Deflection, parallel, mils	D 790	107–162	120–140	44–81
Deflection, perpendicular, mils	D 790	.....	130	46–93
Impact, parallel, ft.-lb./in.	Stamford (*38*)	0.086	0.460	.....
Impact, Izod parallel, ft.-lb./in.	D 256	0.24–0.28	...	1.9–7.0
Taber abrasion resistance	.....	.....	0.025	.....
Dielectric strength, 100°C., v./mil	D 149–44	250–300	140	.....
Arc resistance, sec.	D 495–42	114–134	80–120	Low spots
Dielectric constant, 60 cycles	D 150–45 T	8.5–9.4	...	.....
100 cycles	D 150–45 T	.....	9.42	
1,000 cycles	D 150–45 T	8.1–8.8	7.11	
10,000 cycles	D 150–45 T	.....	6.18	.....
100,000 cycles	D 150–45 T	.....	5.79	.....
1,000,000 cycles	D 150–45 T	7.5–7.9	5.52	
Dissipation factor, 60 cycles	D 150–45 T	0.53–0.83	.....	
100 cycles	D 150–45 T	.....	0.229	
1,000 cycles	D 150–45 T	0.23–0.36	0.135	.....
10,000 cycles	D 150–45 T	.....	0.065	.....
100,000 cycles	D 150–45 T	.....	0.044	.....
1,000,000 cycles	D 150–45 T	0.27–0.29	0.037	.....

[a] Stress applied parallel to molding pressure.

The molded strength and the economic possibilities of the resin pulp preform molding process are intriguing, especially when considered in the light of the decorative effects possible with a light-colored and light-resistant resin or an electrical-insulating resin. The resin pulp preforming process must compete with other processes as has been pointed out by Carswell (*23*) and Darling (*52*). For example, it is possible by postforming techniques to form relatively simple shapes from laminates having high strength and generally excellent properties. Further, by the new low-pressure molding processes based on glass mat or glass cloth and polyester resins, it is possible to obtain very high strength in very large moldings. However, the resin pulp preform molding process has advantages over these other processes. It can be adapted to mechanized handling and the formation of complex moldings with accurate detail. It appears to be potentially a very economic process from all considerations.

In conclusion, the manufacture of large and complex-shaped high-strength durable articles is possible by low-cost methods which are relatively fast and can involve little hand labor. These objects can be produced by more or less continuous operating techniques. A new resin has been presented which, because of its unlimited color possibilities and electrical-insulation properties, vastly increases the scope of the resin pulp preform molding process. In view of these facts, a review of the potentialities of the process by the paper and molding industry is recommended.

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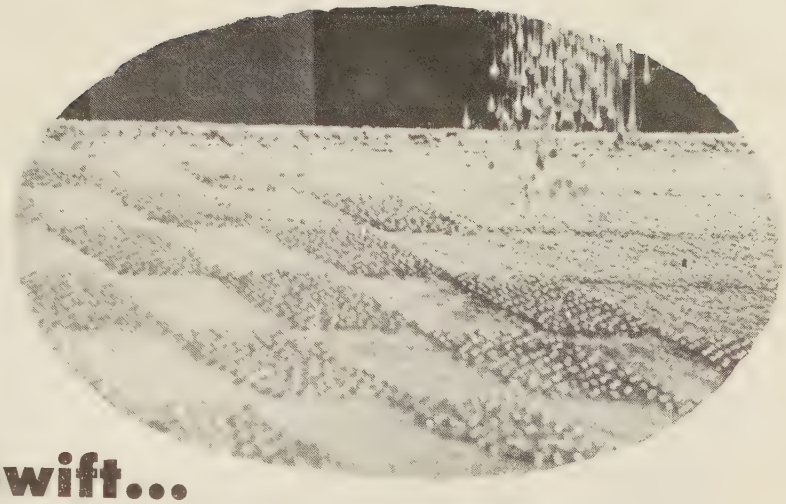

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The author gratefully acknowledges the permission granted him by the American Cyanamid Co. to publish this paper and to the many others in its Stamford Laboratories who have contributed to this development.

Nothing contained herein shall be construed to constitute a permission or recommendation to practice any invention covered by an unexpired patent without a license from the owner of the patent.

CHAIRMAN: Our next paper is by F. L. Graves of the American Cyanamid Co., "Evaluating Abrasion Resistance of Resin—Paper Laminates by the Armstrong Abrader." Mr. Graves has been with this company for 13 years. He is in the Analytical and Testing division, his particular field of interest being in the development of tests.

Evaluating Abrasion Resistance of Resin—Paper Laminates by the Armstrong Abrader

F. L. GRAVES

A PAPER by Gavan, Eby, and Schrader (*1*), published in 1946, included a bibliography of 27 earlier papers dealing with methods and equipment for evaluating resistance to wear. The authors observed that, in spite of the claims made for each approach, no wear test machine has gained widespread acceptance, even within the industry fostering its design. Part of the reason for the welter of test methods lies in the various concepts of the property being studied. Since wear holds a somewhat different connotation for a rubber technologist than it does for a paper technologist, it is not surprising to find a different approach used by each in its measurement. In the final analysis wear is a broad term, implying little more than gradual loss of serviceability in articles of commerce. Because of their diverse natures and uses, no single laboratory technique should be expected to reduce wear to any common denominator.

All materials subject to wear do, however, share in varying degree the important need for resistance to abrasion. In fact, the role of abrasion in wear is so great that the two words are often used, erroneously, as synonyms. At least two abrading devices currently available incorporate the word "wear" in their titles. Perhaps better direction might be given studies in this field if an attempt were made to distinguish more rigorously between the two phenomena. To this end the following two definitions are suggested. The first has been adopted by the plastics committee of the ASTM.

1. Abrasion resistance is the ability of a material to withstand mechanical action such as rubbing, scraping, or erosion, which tends progressively to remove material from its surface.
2. Wear resistance is the ability of a material to withstand the cumulative and integrated actions of all the deleterious influences encountered in use which tend to impair its serviceability.

F. L. GRAVES, Stamford Research Laboratories, American Cyanamid Co., Stamford, Conn.

If these definitions are kept in mind, a more realistic appraisal of wear resistance in terms of abrasion resistance may eventually develop.

The need for acceptance of basic definitions is pointed up by a survey conducted by Juve, Fielding, and Graves (*2*) within the rubber industry. This study revealed not only lack of correlation between laboratory abrasion tests and service performance, but in the case of tire tread compounds lack of agreement regarding service performance as determined in actual road tests.

When the specific nature of abrasion resistance is contrasted with the general nature of service performance, or wear resistance, at least part of the lack of correlation can be explained. Regardless of the machine employed, abrasion tests do not usually consider the other deleterious influences encountered in use. Normally they are run on freshly prepared materials deliberately excluding service conditions which influence this property. In this way, abrasion tests on tire tread compounds, for example, cannot reflect wear resistance when the effect on abrasion resistance of heat of flexure, oxidation, road oils, and other influences normally associated with wear is excluded. In like manner abrasion tests on materials used for table and lunch counter tops will probably not reflect wear resistance when they discount the effect of food chemicals, extreme heat and cold, cleansing agents, sunlight, water, age, etc.

Finally, abrasion tests may not reflect wear resistance when they do not consider the protective measures normally employed to prolong service life, such as the use of resilient backing materials, periodic wax coating, etc.

The ability to assess the wear resistance of any material in the laboratory, will always be directly dependent upon the ability to assess the effect on abrasion resistance of all the major influences present in normal service which work either to promote, or to inhibit, structural damage of the material.

Significant progress in this broader problem rests squarely upon the development of reliable devices for the mechanical measurement of the basic property, resistance to abrasion. Even though laboratory correlation with wear in service may, in many instances, remain elusive, important advancements in screening techniques for product development will be realized as rapidly as we develop and adopt more fundamentally correct abrading devices. It is with this phase of the problem that the balance of this paper is concerned.

There are at least four basic requirements for a satisfactory abrading machine. They are as follows:

1. The device should provide uniform pressure and rate of slippage between specimen and abradant.
2. The abrading action should be intermittent with rest periods sufficiently long enough to prevent significant rise in temperature from friction.
3. The abraded surfaces should resemble, as nearly as possible, the surfaces observed in normal use.
4. The abrading ability should remain uniform throughout the tests.

While all of the established abrading devices can probably meet the first requirement, fewer can meet the first three, and until the introduction of the Armstrong Abrader none can come close to meeting the fourth important requirement—maintenance of uniform abrading ability. Progress toward this goal has been achieved in this device by providing a continuously renewed abrading medium. The device has been described in detail in the paper by Gavan, Eby, and Schrader (*1*). The mechanical arrangement and operation of the Armstrong Abrader are shown schematically in Fig. 1. Essentially the device consists of two independent units: (1) the specimen conveying unit; and (2) the sandpaper feed unit. The first, a vertical, continuous conveyer belt assembly, has eight rigid plates which carry the test specimens downward past

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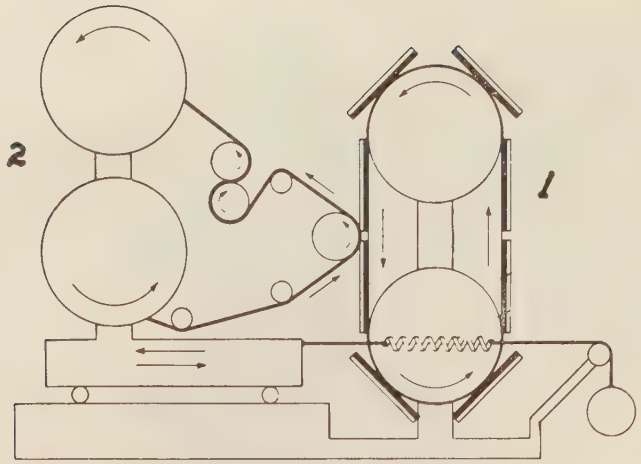

Fig. 1

the abrasive paper contact, at a surface speed of 80 in. per min., providing one abrading pass per specimen every 35 sec. The second unit rests on roller bearings which permit it to move easily toward, or away from, the specimen. A 50-yd. roll of abrasive paper tape, 2 in. wide, is carried on this unit. Threaded from the bottom reel upward through a series of pressure and guide rolls, the paper is drawn past the specimens on a contact roll at the rate of 20 in. per min. Combined with the opposing rate of specimen travel, a total differential speed, or rate of slippage, of 100 in. per min. is obtained. This is sufficiently slow to prevent any appreciable heat generation by the abrading process.

Contact pressure between the specimen and abradant is maintained by dead weights attached to the moving carriage through a cable and spring arrangement as shown. The force applied can be varied between 5 and 50 lb. in increments of 5 lb.

Particles removed from the specimen and the sandpaper during abrasion are carried off by the used sandpaper, thereby minimizing contamination of either the incoming specimen or abradant. The sandpaper roll is discarded after a single use. This one feature sets this device apart from all other abraders. The problem of gumming, clogging, and dulling of the abradant is virtually eliminated. Since the specimens literally walk through the abrasive roll in a sampling manner, reproducibility is not affected by slight variations which may occur within the abrasive paper roll.

The complete machine is illustrated in Fig. 2 This particular abrader was constructed in our laboratories following the general details of the original Armstrong Cork Co. design. A commercial version of this machine is currently available.

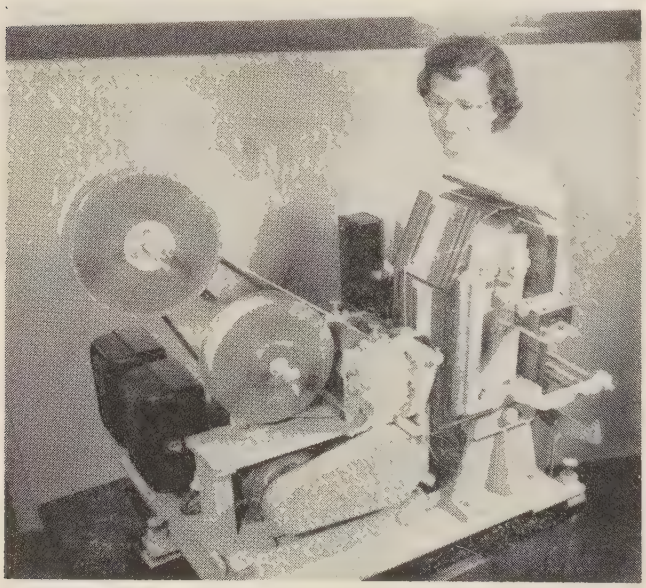

Fig. 2

The standard specimen for the abrader is $1^3/_4$ in. wide and $4^1/_2$ in. long. Since the entire surface of the specimen is abraded in this method, an area of almost 8 sq. in. is evaluated.

Buffer strips of the same material as the specimens are clamped at each end to eliminate irregular edge wear on the test specimens when the abrasive tape passes from one conveyor plate to the next.

The designers of the machine recognized the need to include a reference material in each run in order to check for any differences in abrading ability that might occur among otherwise replicate rolls, as well as among different shipments, of sandpaper. Because of its uniform abrasion resistance, accompanied by suitable weight losses under the desired test conditions, pure sheet zinc has been a satisfactory material for the standard reference. The standard procedures developed for this device, and described in a method soon to be established in the ASTM, are based upon the use of sandpaper calibrated in terms of its abrading action on zinc.

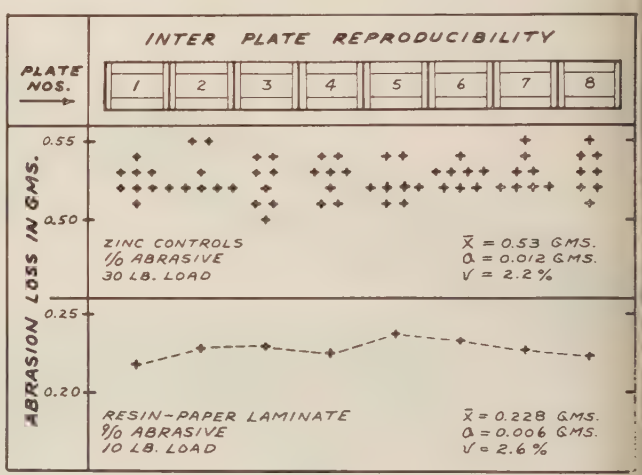

Fig. 3

The number of cycles run per test is determined by the number required to provide a weight loss on zinc within a specified range. The technique used in our laboratories varies slightly from the standard procedure. Two test runs are normally made with each roll of sandpaper. The number of cycles may vary between 70 and 80 and is controlled by the actual length of the sandpaper roll. The run is normal if the zinc loss is in proportion to the standard loss established in the ASTM method. If the zinc loss is outside the established tolerance, the device or the sandpaper would be investigated as being out of calibration. We have rarely experienced such a situation in our work with this machine.

In our test procedure specimens are weighed to the nearest milligram before and after the test run. Weight loss is determined on duplicate specimens and, for uniformity, is expressed in terms of 100 abrading cycles. The average is then converted to volume loss in cubic centimeters per 100 cycles adjusting this value to a standard zinc loss of 250 mg (reference loss for 1 1/0—500 grit flint abrasive paper). If it should be desirable to employ such a test to check the effect of overlay thickness, a factor in wear resistance, of a production item, tests may be run to a visual end point.

The uniformity of replicate specimens of zinc made it possible for the developers of this machine to illustrate the consistent performance of both the device and the sandpaper in eight successive runs employing eight different rolls of standard sandpaper. The results they obtained (*1*) are shown graphically in the upper section of Fig. 3. The weight losse

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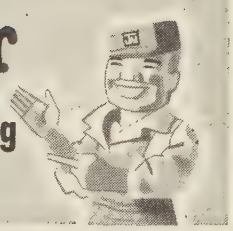

Keep equipment in repair for best packing service

Worn shafts wear me down

Trying to make packing compensate for excessive shaft or rod wear will shorten packing life materially without alleviating the undesirable condition. Pack correctly to avoid excessive shaft and rod wear. Replace worn shafts and rods as soon as possible to avoid adding the expense of damaged packings to the cost of parts replacement.

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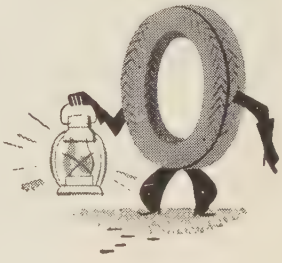
Packings are for sealing only. Trying to compensate for shaft misalignment or vibration by overpacking and excessive gland pressure results in scored shafts and ruined packing. Think of a stuffing box as a potential brake assembly that may develop considerable frictional resistance with attendant heat and wear.

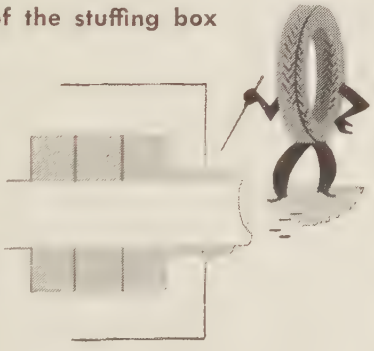
Keep my lantern clear

If the stuffing box is equipped with an oil, grease or water lantern, its purpose is defeated when the lantern ring is omitted or the opening blocked by improperly installed packing or other obstruction. This can deprive the packing of lubrication or cooling and result in premature failure.



Don't let me get out of the stuffing box

If the shaft or rod is badly worn, the packing may be extruded into the system when the gland follower is taken up. Considerable difficulty such as packing getting into valves or gaps or contaminating the fluid handled may result. Rebush the stuffing box or use a junk ring to reduce the clearance.



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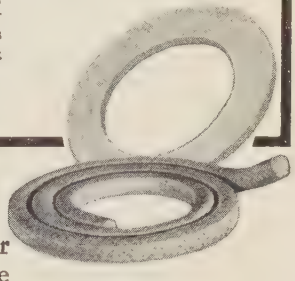

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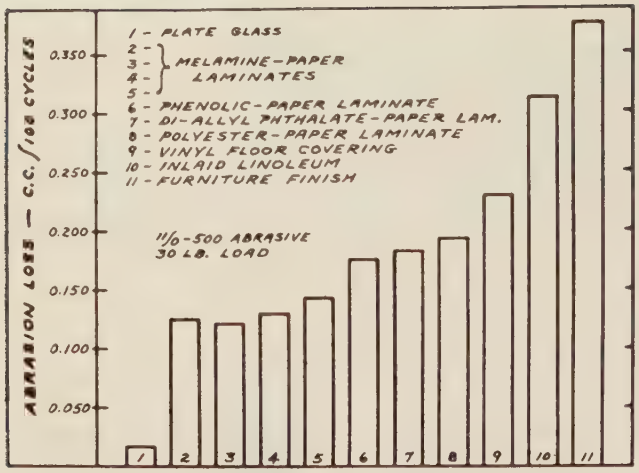


Fig. 4

for each of the eight runs are plotted for each conveyor plate. The average weight loss for the 64 determinations is found to have a coefficient of variability of only 2.2%.

In the lower section of the figure weight losses are plotted for eight replicate specimens taken from a single 12-in. square polystyrene-paper laminate. This run was made on our machine to check the within-sheet uniformity of a resin-paper lamination. A coefficient of variability of 2.6% was obtained. Our experience with plastics, generally, has indicated variability to be seldom over 5%, compared with figures of about 20% reported for other types of abraders. As will be noticed, this work was not done with the same operational conditions.

The abrasion resistance of a variety of resin-paper laminates is shown in Fig. 4 along with that of some other common materials in everyday use. This bar chart indicates the relative abrasion resistance of these materials as evaluated on the Armstrong Abrader using No. 11/0—500 abrasive paper. This paper, known in the leather finishing trade as "snuffing" paper, is a uniform flint abrasive which has been adopted in the very fine 500-grit form, as the standard abradant for rigid materials. It provides gradual attrition, developing satiny surfaces which resemble those found on furniture in service. Referring again to the figure, bars 2 to 6 represent commercial resin-paper laminates, 2 through 5 being representative melamine resin laminates. It is interesting to compare the abrasion resistance of the resin-paper laminates with the quality linoleum product reflected in bar 10. If the common mistake is made of attempting to read wear resistance where only abrasion resistance is written, the immediate reaction may be unfavorable to this evaluation. Linoleum is known for its excellent wear resistance. If, however, we approach these data with the basic definitions of

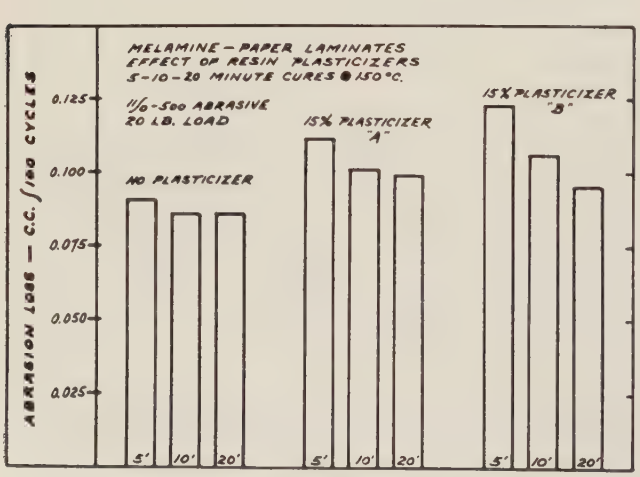


Fig. 5

wear and abrasion resistance clearly in mind, the reasonableness of these data becomes at once apparent.

The abrasion resistance of these materials has been measured. What has not been evaluated is the effect of those influences which affect abrasion resistance and its role in serviceability. For example, no attempt is made to evaluate the 20:1 thickness ratio of serviceable material between linoleum and resin-paper laminates which has much to do with wear resistance. In other words, the superior abrasion resistance of the resin-paper laminates is not so important when the thickness and wax coating play their part in the wear resistance of the linoleum.

In some instances the relative abrasion resistance of materials may carry through to service performance without complication. The marked superiority in the abrasion resistance of resin paper laminates over a typical, high-grade, commercial furniture finish may, for example, account for the successful use of these materials for table tops without the protection of tablecloths normally used over wood finishes.

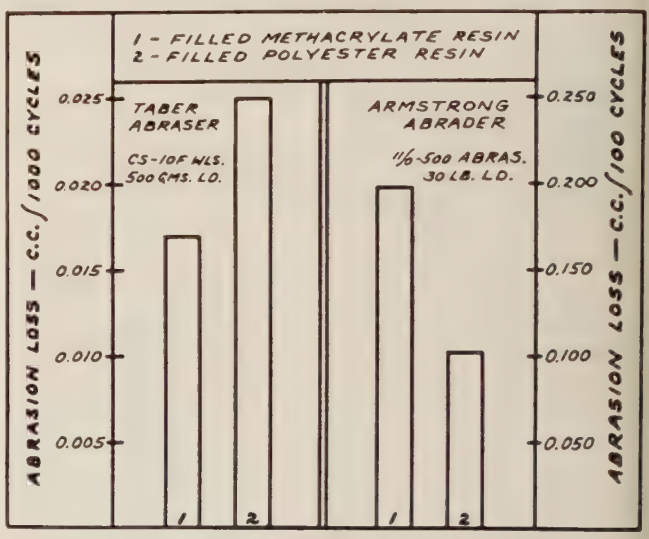


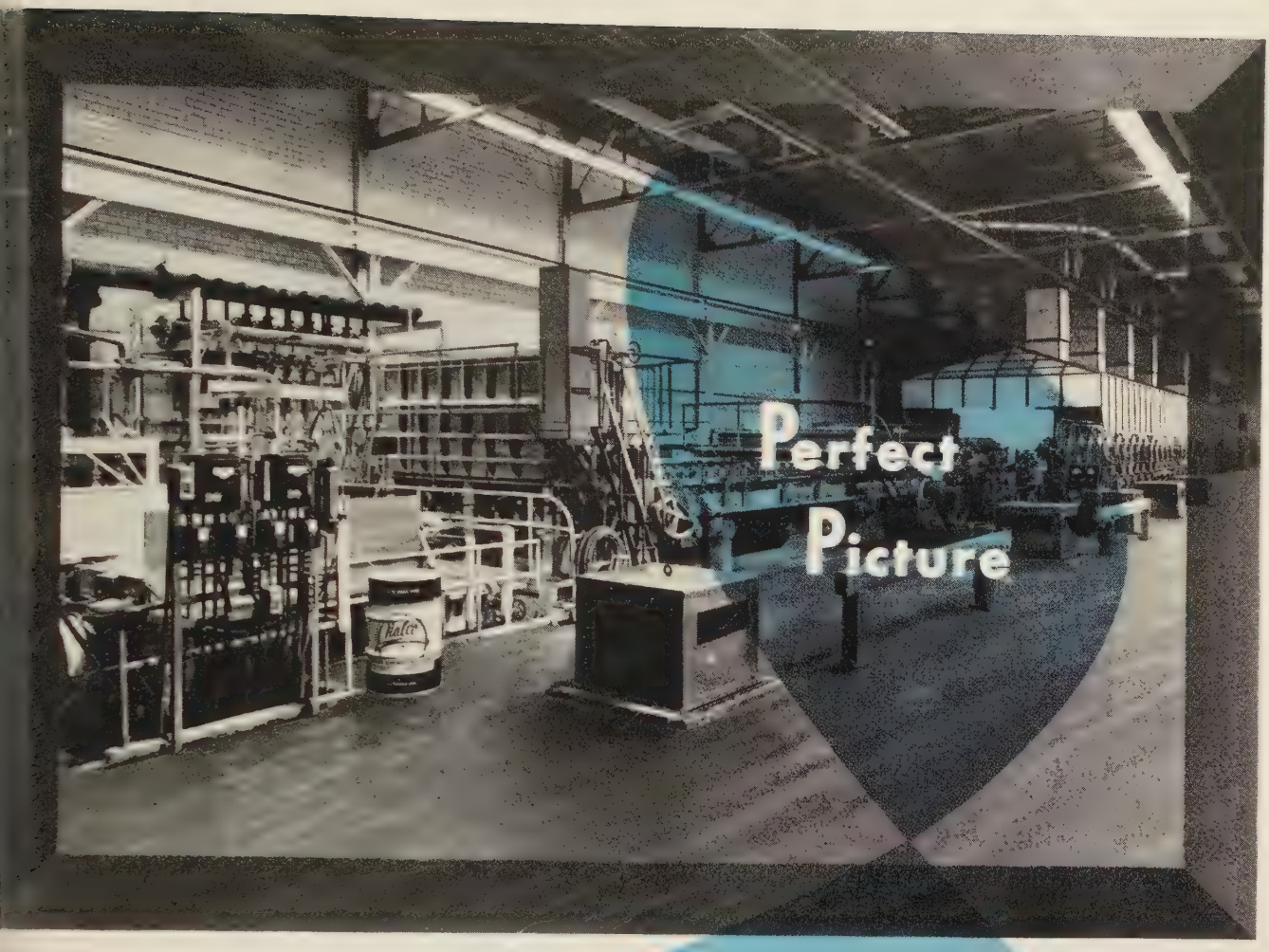
Fig. 6

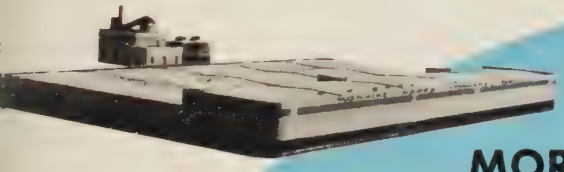
It may be significant to note that the two high abrasion losses shown on this chart were obtained on materials that normally receive periodic waxing in service. Perhaps this protection should be normal procedure for resin-paper laminates as well.

Regardless of the need for methods by which we may compare the wear resistance of materials, a reliable abrasion resistance test can be a valuable tool in product development.

The effect of formulation and process changes on abrasion resistance must be considered in any quality analysis. An example of the effect of experimental plasticizers in melamine-paper laminates is shown in Fig. 5. The maximum abrasion resistance is obtained in the unplasticized resin at the 10-min. cure. Experimental plasticizers A and B affect both the rate of cure and the abrasion resistance in varying degree. Other plasticizers might show somewhat different effects.

Whenever a new instrument is developed the question of correlation with existing devices is immediately raised. If the design is the result of unsatisfactory experience with the values obtained on older machines, correlation would be tantamount to failure in the effort to progress. On the other hand, lack of correlation without improved accuracy brings only further confusion to the problem. Inasmuch as the Armstrong Abrader was not designed in our laboratories, we feel that we have been reasonably objective in its appraisal. We have found both areas of correlation and lack of it with the Taber Abraser. An interesting example of the latter is shown in Fig. 6. The comparison of a filled polyester resin





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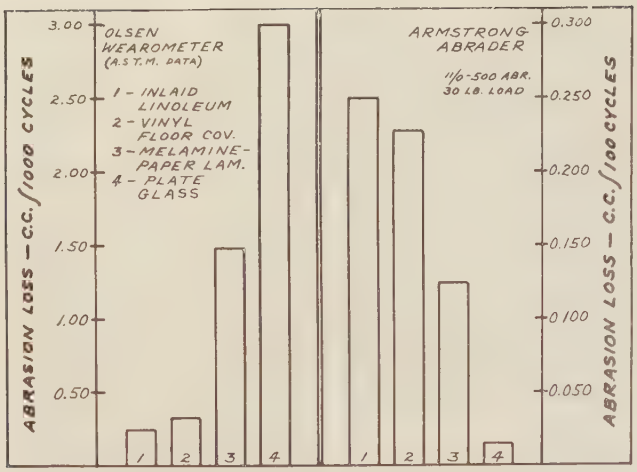

Fig. 7

with a filled methacrylate resin in our laboratories, using the Armstrong Abrader, indicated the abrasion loss for the polyester resin to be 48% less than that for the acrylic resin. Tests obtained at a commercial testing laboratory by a customer indicated the same materials to be reversed when tested on the Taber Abraser. The polyester resin was found to have an abrasion loss 46% greater than the acrylic resin. Since our experience has indicated a tendency for the abrading surface of Taber wheels to clog at different rates when used on dissimilar materials, we are inclined to favor the Armstrong data.

A more striking example of the problems which exist in measuring abrasion resistance is given in Fig. 7.

The comparative qualitative rating of these dissimilar materials on the Olsen Wearometer was taken from data obtained in a round-robin test conducted in the ASTM (*3*). The comparative data using the Armstrong Abrader were obtained in our laboratories on similar, but not duplicate materials. While we have had no experience with the Olsen Wearometer upon which to draw in judging the relative reliability of these data, there is reason to believe that the Olsen Wearometer, which employs loose abrasive, is at some disadvantage when evaluating materials whose surfaces are readily embedded with abrasive grit. The easily penetrated surface of the linoleum may have become loaded, impairing the abrading action of the loose abrasive on the work table. At the other extreme, the impenetrable surface of the plate glass may have permitted the maximum abrading action by the loose abrasive.

Quantitative differences among materials of widely different hardnesses, such as those shown in Fig. 7, will probably vary with the hardness of the abrading medium employed. For example, if the Carborundum abrasive used on the Olsen Wearometer were used on the abrading tape of the Armstrong Abrader, in place of the softer flint abrasive, the superiority of plate glass might be less striking.

It is not intended to imply, by the meager information in these charts, that there may not be wide areas of correlation between these three machines when evaluating similar materials. These particular examples were chosen to reflect the effect of their diverse mechanical actions on the comparative abrasion resistance ratings obtained. If all three instruments were reliably measuring the basic property, defined earlier as resistance to abrasion, there would be qualitative correlation in their data. If further work with the Armstrong Abrader supports our belief that it comes closest to an unencumbered mechanical method for removing material from the surface of specimens, the cornerstone will have been laid upon which to build toward correlation with wear resistance.

In working toward this objective consideration must be given to the contribution of resilience in resistance to abrasion. Both the inherent resilience of the material and that achieved through backing materials play a major role. As we become more expert in assessing the influences of service conditions we will move more rapidly toward better correlation with wear resistance.

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Appreciation is expressed to Frank M. Gavan of the Armstrong Cork Co. for permission to draw on data from the original paper in our description of the Armstrong Abrader, and to the ASTM for permission to reproduce the data forming part of Fig. 7.

Question: The first question is to Mr. Barry about the silicones and my first question is about the solubility of the alkyl—shall we say "silicone" to make it simple—that is, the phenol derivatives as compared to the methyl.

Mr. Barry: They both have a general solubility in organic solvents. The phenols will be more soluble in materials like alcohol. Methanol, for instance, will precipitate a methyl silicone but not a correspondingly substituted phenol. There will be differences in solubility with the phenol group favoring more organic solubility but we are arguing a very fine point.

Question: The reason I ask this is that foam killers are methyl silicones and they don't seem to be soluble in toluene. They form a cloudy suspension.

Mr. Barry: There are other materials in the foam killers than just silicone but they are readily enough dispersible in a colloidal sense to be applicable for their use.

Question: But methyl siloxane itself will be soluble?

Mr. Barry: Yes.

Question: The other question is to Mr. Lindenfelser. I think you mentioned this but I am not sure I understood it. These are water-soluble resins that are used?

Mr. Lindenfelser: They are insoluble.

Question: They are not made soluble by the addition of acid?

Mr. Lindenfelser: No, they are not.

Question: They are used in alcoholic solutions?

Mr. Lindenfelser: They could be.

Question: Your recommendation is?

Mr. Lindenfelser: In our experiments we added them as finely divided powder. They could be added as alcohol solutions.

Question: I'd like to ask Mr. Lindenfelser a question. Can these resins be added as water dispersions or water emulsions?

Mr. Lindenfelser: Yes, they can.

Question: Do you get good retention in the pulp preform if you use them?

Mr. Lindenfelser: Our experience is that the retention is as good as with phenolic resins. The water solubility of the especially prepared resin is extremely low—as low as the phenolic resins, possibly lower.

Question: You add them to the pulp slurry and then precipitate them?

Mr. Lindenfelser: No. In our experiments we added these very finely divided resins. The retention is strictly a filtering action although there seems to be some affinity of the pulp for resin when the resin is finely divided. I might add our experiments indicate it can be used exactly in the same way phenolic resins are used. The one exception is it is not possible to dissolve these resins in alkali but they can be obtained by completely dispersing a finely divided solid or adding an emulsion to the precipitation.

Question: I realize these are experimental resins you have been telling us about but could you give us an idea of the price that will be charged for them when they become available?

Mr. Lindenfelser: I don't think I can. Potentially it should be a relatively low cost. It would not be as cheap as phenolic resins though.

Question: How would it compare with melamine resins?

Mr. Lindenfelser: I am afraid I can't answer that. It is in the developmental stage.

Question: Can you give a comparison between these resins and melamine formaldehyde resins?

Mr. Lindenfelser: It is difficult to make a direct comparison with the melamine resin. You have to define the conditions under which you are making the comparison.

Question: On the charts you prepared, you showed 60% pick up, is that the maximum you feel could be obtained?

Mr. Lindenfelser: No. I don't think, generally speaking, that is all you would want. To put more resin in would be to make the molded composition more expensive and I doubt you'd have any significant improvement in its properties.

Question: Does the addition of those resins in a finely powdered state give good uniformity such as a phenolic resin would have?

Mr. Lindenfelser: I think so. I am afraid we don't know enough about all of the details of the pulp preforms to give a

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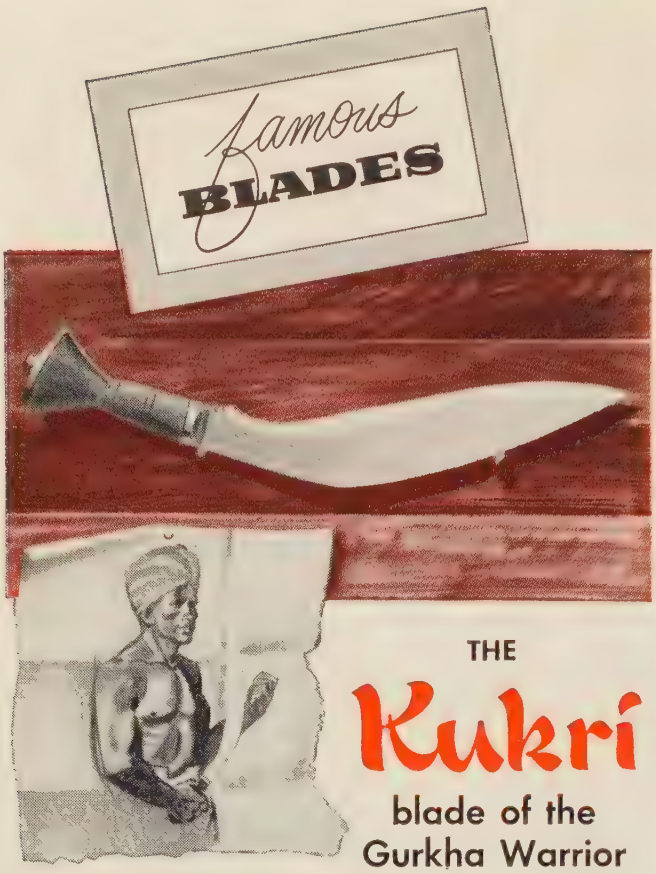
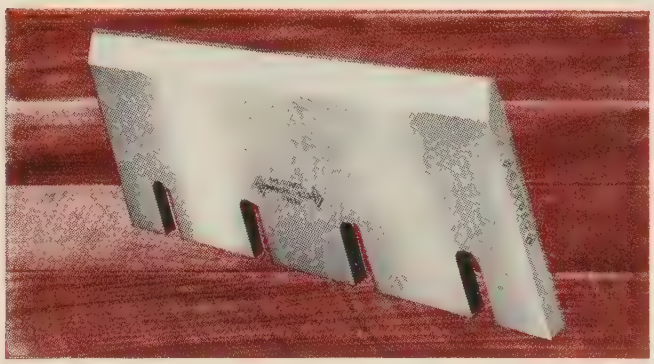
PULP DIVISION **WEYERHAEUSER**





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absolute answer to that but our experiments certainly indicate you do get as good uniformity. There is a lot of technique, of course, involved in the pulp preform operations. We are not in that business and don't know all the details.

Question: What is the shortest possible curing time it would take?

Mr. Lindenfelser: We did not make any specific attempts to obtain fastest cure. The data which I have shown you on the chart earlier were obtained in a 5-min. cure at 150°C. Now, I know it is possible to go to shorter cures and higher temperatures can be used because of the heat resistance of benzoguanamine resin. Whether it will be possible to achieve as fast cures as can be obtained with phenolic resins, I don't know. I think so. I think you can obtain a faster cure. Of course, again, you must remember that although it is possible to obtain very fast cures with conventional molding materials in small parts, when you go into larger sized parts, where the economics of this process would become advantageous, you do go to longer cures. For example, a radio cabinet is not cured in the time a button is cured.

Question: I realize your paper has been on pulp preform molding. I'd like to ask you—as an obvious extension—can you put that same stock in the paper machine?

Mr. Lindenfelser: You know that is an interesting subject but we haven't done it. I know of no reason why it could not be done.

Question: What about water resistance?

Mr. Lindenfelser: We have data on the preform which indicate you can get good water resistance, hardness, etc. We have made flat sheets by other processes which indicate you can get the same properties.

Question: But you don't have any information on the extent you can foul up your air filters?

Mr. Lindenfelser: That is true.

Question: What is the absorption point of the resin?

Mr. Lindenfelser: I will answer it this way—we can control it.

Question: I'd like to ask Dr. Barry—these linear polymer chains you say have a high lineal polymerization—are they waxes or what?

Mr. Barry: At a molecular weight of a million, they are very tough—almost like super polyethylene and they become almost rubbery in characteristics but they will flow. They vary from thin liquids to quite viscous fluids to a very tough, rubbery fluid.

Question: Still they are linear?

Mr. Barry: They are still linear.

Question: I'd like to ask—do you know about fabric abrasion? How do you think this test would work on fabrics?

Mr. Graves: We feel that it should have possibilities in the textile field and are planning to explore its use on fabrics in the near future. It provides an opportunity to work with fine abrasive papers that would become quickly clogged on machines that do not provide for continuous renewal of the abrading medium.

Question: I was curious about water resistance.

Mr. Lindenfelser: We have tested it and it is good—as good as phenolic resins. I don't expect, however, that this resin—let me put it this way—it will be a long time before these resins would compete with phenolic resins because of economics.

Question: You have talked about preforms but I think when you talk about these products being made from sheets you would be getting into trouble.

Mr. Lindenfelser: I think that is a good point but we have not explored that field at all and, as you know, there are many methods proposed by American Cyanamid and DuPont and other companies working in the field of precipitating resins from the emulsion state to fibers and I think it can be worked out. We haven't done any work on it.

Question: I would like to ask Mr. Barry a question. Would the solubility of a mixed phenylmethyl silicone resin be superior to the solubility of phenyl—in terms of alcohol solubility?

Mr. Barry: The difficulty of answering that question—you are thinking of a resin....

Question: I am thinking certain silicones are useful in modifications of resins and, vice versa, certain of the silicones are not so compatible with resins and don't have solubility in lower alcohols. I am wondering if the mixed substitute is superior in that respect.

Mr. Barry: I believe it would be but then it is often necessary to vary the procedure of condensation methods so we are not making a comparison between comparable structures. The introduction of a phenol group will introduce greater solubility in nonpolar solvents. I am not sure of the effect on the resin in alcohols. I think if you are interested in resins we could probably find a resin that would be suitable.

Question: I'd like to ask Mr. Graves—you doubtless are familiar with the abrasion test in ASTM Standards—what is your opinion of that as compared with the Armstrong, because we have discussed the relative merits of the two and we feel the Armstrong test setup itself is rather expensive?

4 B&W RECOVERY UNITS

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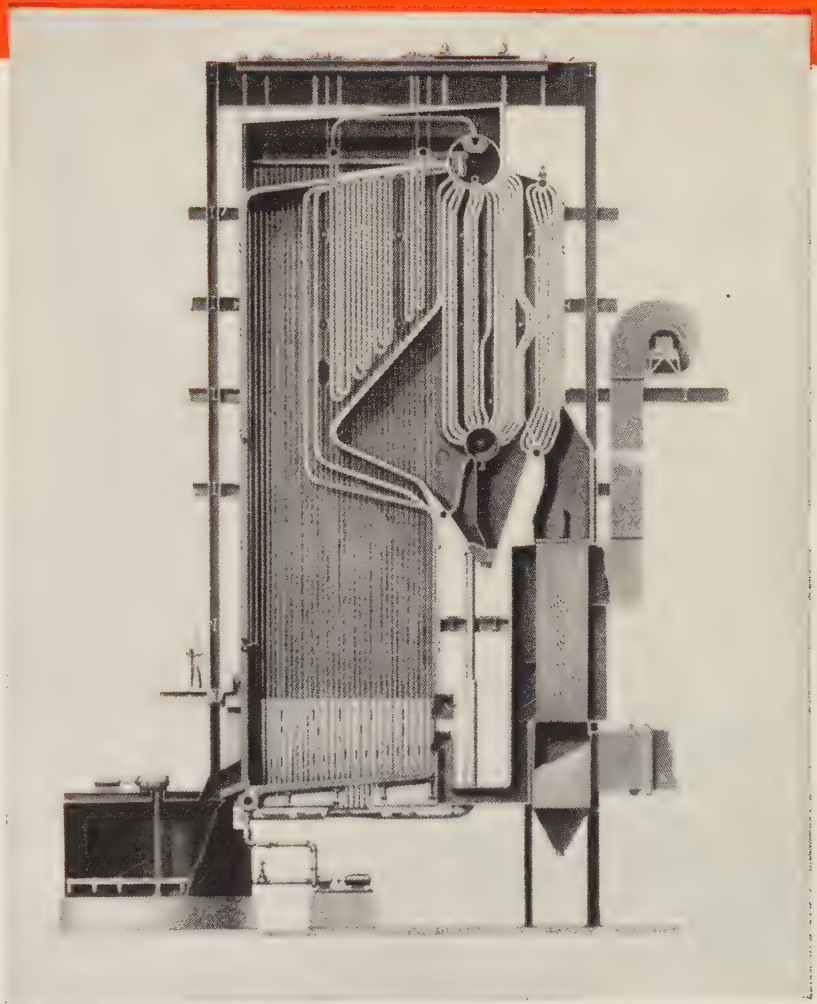

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P-772

Mr. Graves: That is a problem. The machine is likely to cost over $2000. It depends on how many orders they get for it.

Both the ASTM and the NEMA modification carry the limitations of clogging of the abradant which has been eliminated in this device. Since different materials may show different clogging rates misleading data are often obtained. We feel that the reliability of the data obtained with this device warrants its rather high initial cost.

Edwin Jahn: This morning the program will be concerned with plastic applications to paper. I'd like to point out that yesterday's program was organized and arranged largely through the efforts of Mr. Mark and today's program has been arranged by Mr. Nazzaro, who is chairman of the Subcommittee on Plastics in Paper Converting. Without further ado, I will turn the meeting over to R. T. Nazzaro, who will be chairman of today's session.

Plastic Applications to Paper

Chairman: It has been customary at the plastics meeting to devote some time to the application field of plastics to paper. The first speaker this morning is Larry Egan. Mr. Egan is a graduate of Stevens Institute of Technology with a mechanical engineering degree and is presently Secretary of Frank W. Egan and Co. He will speak on "Machinery for Coating Paper with Plastics."

Machinery for Coating Paper with Plastics

R. C. STURKEN and L. W. EGAN

The manufacture of plastic coated papers, although basically an old industry, has been marked by a considerable expansion and by a number of new developments in recent years. The term "plastic" as applied to paper coating may be said to include all of the various natural and synthetic resins and high polymers and elastomers which may be used to apply a thin film or surface coating on a web of paper. These materials are generally applied to paper to improve its functional properties for such uses as packaging, as contrasted to the clay and other inorganic pigment coatings which are used to improve the printability of paper.

Among the older types of plastic materials used for coating paper may be included the varnishes and lacquers made from natural resins and gums, and natural rubber and rubberlike materials. Among the synthetic materials are nitrocellulose, cellulose acetate, and other cellulose derivatives, the entire family of vinyl compounds including polyvinyl chloride, acetate, and alcohol, and polyethylene, as well as such materials as nylon, the various synthetic rubbers and the great variety of copolymers and other resins developed in recent years. The uses and properties of papers coated with these materials have been discussed in recent literature (*3*, *17*, *21*, *25*).

The saturation, as contrasted to the coating, of papers with plastics is considered a separate subject which has been treated previously (*7*) and will not be included in this discussion. The general types of machinery used for coating paper have been well described in the literature (*6*, *17*) and are the subject of TAPPI Monograph No. 8, "Machinery for Paper Coating" (*8*).

In this paper the types of equipment used specifically for coating paper with plastics will be discussed, including a review of the older conventional types and a more detailed discussion of the newer machines developed specifically for plastics.

R. C Sturken, and L. W. Egan, Frank W. Egan & Co., Bound Brook, N. J.

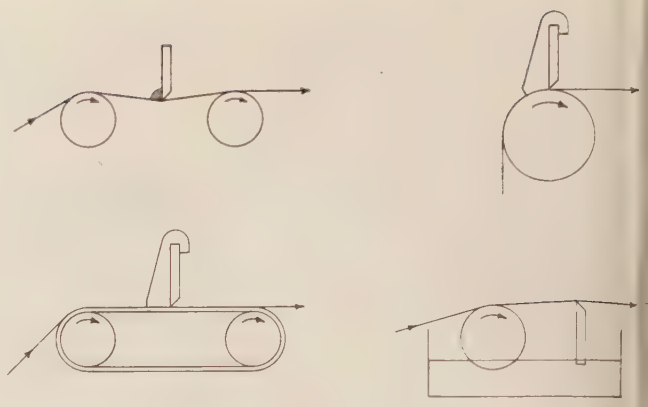

Fig. 1. Knife coaters

These machines may be divided into the following gener categories:

1. Conventional equipment for applying suspensions and sol tions of plastics resins.
   - A. Coating machines.
   - B. Driers and ovens.
2. Adaptations of conventional coating machines for ho melt application of low to medium viscosity resins.
3. New extruder fed equipment for hot-melt application high viscosity resins.
4. New equipment for direct extrusion-lamination process f high viscosity film-forming resins.

The various types of equipment falling within these cat gories will be discussed in the approximate order in whic they were developed, with emphasis on the newer types.

CONVENTIONAL COATING EQUIPMENT FOR SOLU TIONS AND SUSPENSIONS

As plastics were developed which were found to be usef in coating paper, it was natural that attempts would be ma to apply these coatings on machines already in existenc Most of the older types of coating machines were origina developed for aqueous coatings such as clay coatings. though only a few plastics are soluble in water, many plas materials can be dissolved in organic solvents and more r cently techniques have been developed for suspending emulsifying resins in water. Natural and synthetic rubbe can be emulsified with water to form a latex. Some materia such as polyethylene and certain vinyl compounds can dissolved only in hot solvents (*23*), while vinyl resin may suspended in a nonvolatile liquid plasticizer to form a plastis The purpose of forming these mixtures and dilutions is reduce the plastic to a relatively low viscosity liquid whi could be handled on coating machines designed for that ty of material.

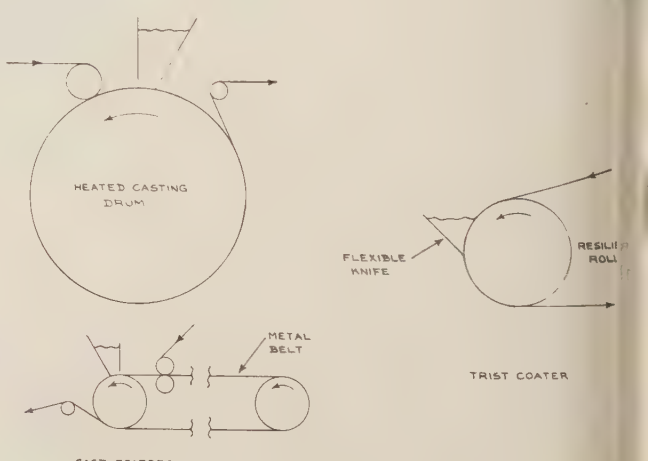

Fig. 2

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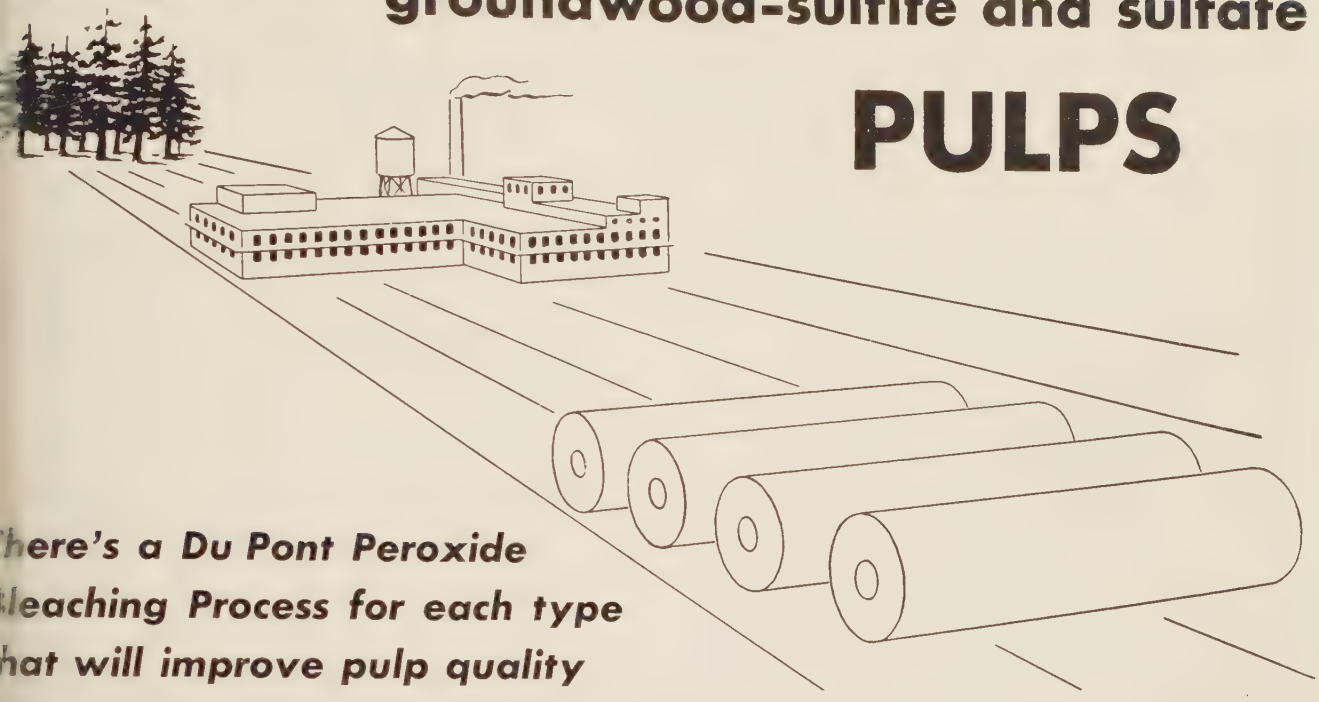

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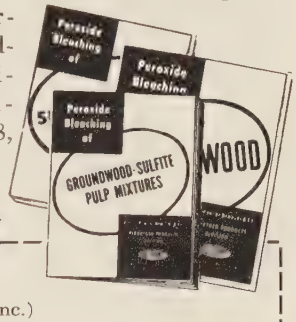

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Knife Coaters

The knife coater is one of the oldest and simplest types of coating machines. Four basic types are shown in Fig. 1. These include the floating knife, the knife-roll, the knife-blanket, and the inverted knife which uses a pan and furnish roll. The advantages of the knife coater are its simplicity and relatively low cost, and its ability to handle very high viscosity coatings, particularly in the case of the knife-roll type.

This type of coater has several disadvantages, however, the most serious one being the inaccuracy of control of the coating thickness. Thus the thickness is affected not only by the clearance of the knife above the paper or the pressure upon it, but also by the thickness of the paper, by the viscosity of the coating, and in several cases by the tension in the paper. The coatings produced also frequently contain streaks which are readily caused by nonuniformities and the small foreign particles present in most coating mixtures. In addition pinholes and bubbles are frequently present which make it necessary to apply several coats in order to obtain a continuous film. This type of coater has, however, been widely used in the past for pyroxylin, rubber, and vinyl coatings and continues to be used for high viscosity materials on the order of 50,000 to 500,000 cp. where accuracy is not important.

Another type of knife coater is the so-called cast coater, where the coating is applied directly to the highly polished surface of a metal drum or endless belt. This is shown in Fig. 2. The paper is then applied after the coating has been laid on the drum or belt. This type of coater is free from the inaccuracies of the types described above but is subject to streak formation if any foreign particles are present and is high in cost. This will be described further under drying equipment.

Also shown in Fig. 2 is the Trist coater which has recently been announced (*26*, *27*). In this case the coating is applied by a flexible knife blade set at an angle to a resilient backing roll which is said to give improved uniformity. This coater is designed for oil phase emulsions of very high solids content, and is said to be capable of applying resin coatings at speeds in excess of 3000 f.p.m.

Air Coater

The air coater, also called the air brush or air knife coater, is shown in Fig. 3. This machine was originally developed for applying aqueous dispersions of clay and other inorganic pigments. More recently, it has been adopted to a limited extent for the coating of water solutions, emulsions, and latices of plastic materials. It has the advantage of relatively high coating speeds on the order of 1000 f.p.m., and freedom from streaks. The coating thickness is uniformly controlled by the air pressure in the air knife but is also affected by the viscosity of the coating.

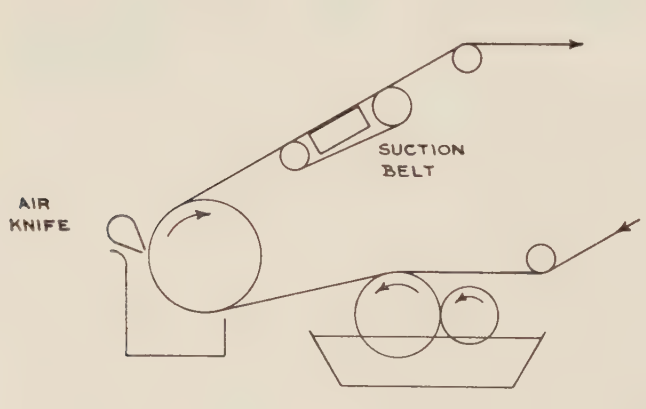

Fig. 3. Air coater

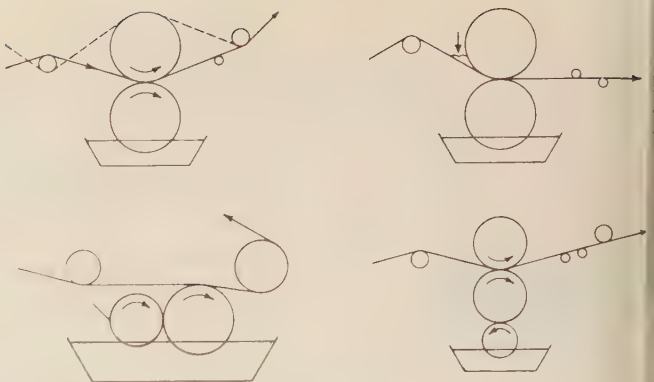

Fig. 4. Roll coaters

The disadvantages of the air coater for plastics are that i cannot be used safely on solvent solutions and can handle only dilute low viscosity coatings. In addition it is subject t foaming, overspray, and agitation and partial drying of th recirculated coating.

Roll Coaters

The roll coater is also one of the oldest types of coatin machines. Several arrangements of roll coaters are shown i Fig. 4. Thus the coating may be applied directly from a ro revolving in a pan of the liquid, or a transfer roll may be used The paper may be held against the coating roll by means o another roll or by means of its own tension. By the use o precisely ground, chilled iron coating rolls, very accurat coating weights can be applied, subject to variations in th web caliper.

The two-roll vertical-type coater can be used for applyin accurate coatings to both sides of a web simultaneously, b pumping part of the coating to the top side of the web as enters the roll. This arrangement is used for applying lacque to smooth uniform webs such as cellophane and glassine.

Roll coaters have two principal disadvantages, in that th generally produce a ribbed rather than a smooth coati and the rolls tend to deflect as the viscosity and/or speed increased. The ribbed effect of the coating can be smoothe by a number of devices including stationary smoothing ba small smoothing rolls which are driven slowly against t travel of the web, or wire wound doctor bars. The deflecti of the rolls which is caused by fluid pressure at higher spee and viscosities, can be compensated by grinding the coati rolls with crowns. This considerably reduces the flexibili of the machine, however, as the crown is suitable for on one set of operating conditions.

Reverse Roll Coaters

The reverse roll coater has been developed to give a ve precise coating without the numerous disadvantages of t knife and roll coaters. Four arrangements of rolls in t reverse roll coater are shown in Fig. 5. Fundamentally, t coating is applied to the paper by means of a casting r traveling in the opposite direction to the paper. The thi ness of the coating on the casting roll is controlled by a met ing or doctoring roll traveling in the opposite direction to t casting roll, and the final thickness on the paper is increas in relation to the speed ratio of the casting roll to the paper (

Because the roll surfaces travel in the reverse direction each other, there is no fluid pressure between the rolls and th may be ground with a straight face without crown. T coating thickness has been found to be independent of coating viscosity and of the speed, and a wide range of v cosities from about 100 to 100,000 cp. can be handled.

The reverse roll coater is a very versatile unit which widely used for applying solvent solutions of resins as well water suspensions and plastisols. Its disadvantages are t

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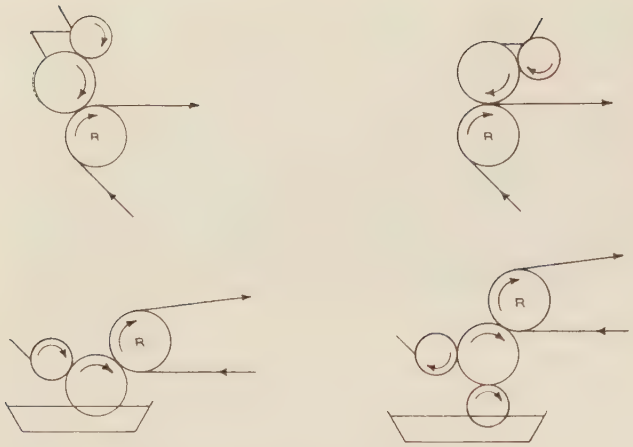


Fig. 5. Reverse roll coaters

R = resilient roll.

it has a top speed, limited by shearing of the coating, of about 600 f.p.m., and that the minimum practical wet thickness of the coating is about 1 mil. It also produces a ribbed coating under certain conditions, which can generally be eliminated, and in some cases bubbles are introduced into the coating in the fountain or pan.

Print Roll Coaters

Print roll coaters of the rotogravure or intaglio type have found considerable use in applying solvent solutions of plastics. The two basic types including the direct gravure coater and the gravure offset coater are shown in Fig. 6. In each case the coating is metered by an engraved roll with an oscillating doctor blade. For high-speed operation a slower speed furnish roll revolving in the pan of coating can be added to either type.

The gravure coaters have the advantage of being able to apply low coating weights with very high precision, and of being able to handle medium viscosities. The coating weight is determined only by the depth of the engraving in the print roll and by the solids content of the coating.

The coating produced by the direct gravure coater consists of a series of small dots or lines depending upon the pattern of the engraving. Since a continuous film is generally required, this pattern must subsequently be smoothed and devices similar to those used with roll coaters, such as smoothing bars, doctor rolls, and wire-wound doctors can be used after the gravure coater.

To eliminate this pattern in the coating machine itself, the gravure offset unit can be used in which the coating is offset from the gravure roll to a rubber offset roll and thence to the paper. The elasticity of the rubber partially smoothes the coating as it is picked up from the gravure roll, and smooths it further as it is printed onto the paper with the result that a relatively uniform film is produced. This type of coater is naturally limited to those coatings in which the solvent does not attack the natural or synthetic rubbers which can be used for the offset roll.

The gravure-type coaters are recommended for applying thin coatings of plastic solutions but have the disadvantages of inflexibility with regard to coating weight and inability to apply higher coating weights.

Extrusion Coaters

In order to apply solvent solutions of resins and rubberlike materials of very high viscosity which could previously be handled only on a knife coater, an extrusion-type coater has been proposed (*13, 14*). This is illustrated in Fig. 7. It consists of an extrusion head with an adjustable slot for controlling the thickness of the extruded coating. The high viscosity material is fed from a reservoir through a pump and pipe to the extrusion head. With this arrangement, the paper is passed over a driven head roll in close proximity to the extrusion head and the coating is stretched and allowed to fall upon the paper. It then passes to the drier in the usual manner.

With another arrangement shown in Fig. 7, the extrusion head consists of a restricted slot opening which is not adjustable. The paper is drawn directly over the slot opening and then over a smoothing device, with the coating thickness being controlled by the relative feed rates of the coating and the paper (*28*).

Although these machines appear to have advantages over the knife coater for very high viscosities, they have not found wide use for coating solvent-plastic mixtures.

Driers

After solutions and suspensions of plastic coating materials have been applied to paper, it is necessary that they be dried to remove the solvent or water present. The conventiona equipment for accomplishing this drying is the air drier several arrangements of which are illustrated in Fig. 8 Fundamentally these include the horizontal air drier, the arch-type drier, and the tower drier. In the horizonta drier, the paper is supported by means of a conveyor or a series of rolls. If it has been coated on both sides, it is supported by means of a floater-type drier where jets of high velocity air are discharged from the bottom air header Double-coated paper may also be dried in the vertical drying tower.

The arch drier is used principally for dilute water-soluble coatings which tend to cause curling of the paper. By drawing the paper under tension over the series of rolls forming the arch while drying, this curling tendency is minimized

The air for these driers is generally recirculated by a blowe through a source of heat such as steam coils, direct or indirec gas or oil-fired burners, or electric heating coils. If an in flammable solvent is being evaporated, air must be exhauste at a rate which will keep the solvent concentration below 20% of the lower explosive limit.

Since most organic solvents are relatively expensive it common to install a solvent recovery system on all larg sized installations. The activated carbon-type adsorptio system for solvent recovery is most widely used. At one tim it was a practice to operate above the upper explosive limi and to recover the solvent by condensation, but this was hazardous procedure that frequently resulted in explosions With the discovery of the activated carbon adsorption proc ess, it has been almost universally adopted in preference t the condensation method of solvent recovery.

More recently radiant heat in the infrared spectrum being used for drying plastic coatings. The infrared radiatio can be generated by electric lamps, by electric resistanc heaters with parabolic reflectors, or by plane surface heate which can be heated electrically or by gas.

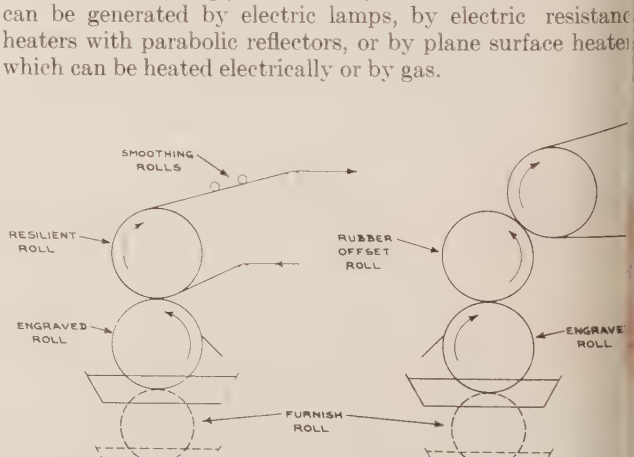
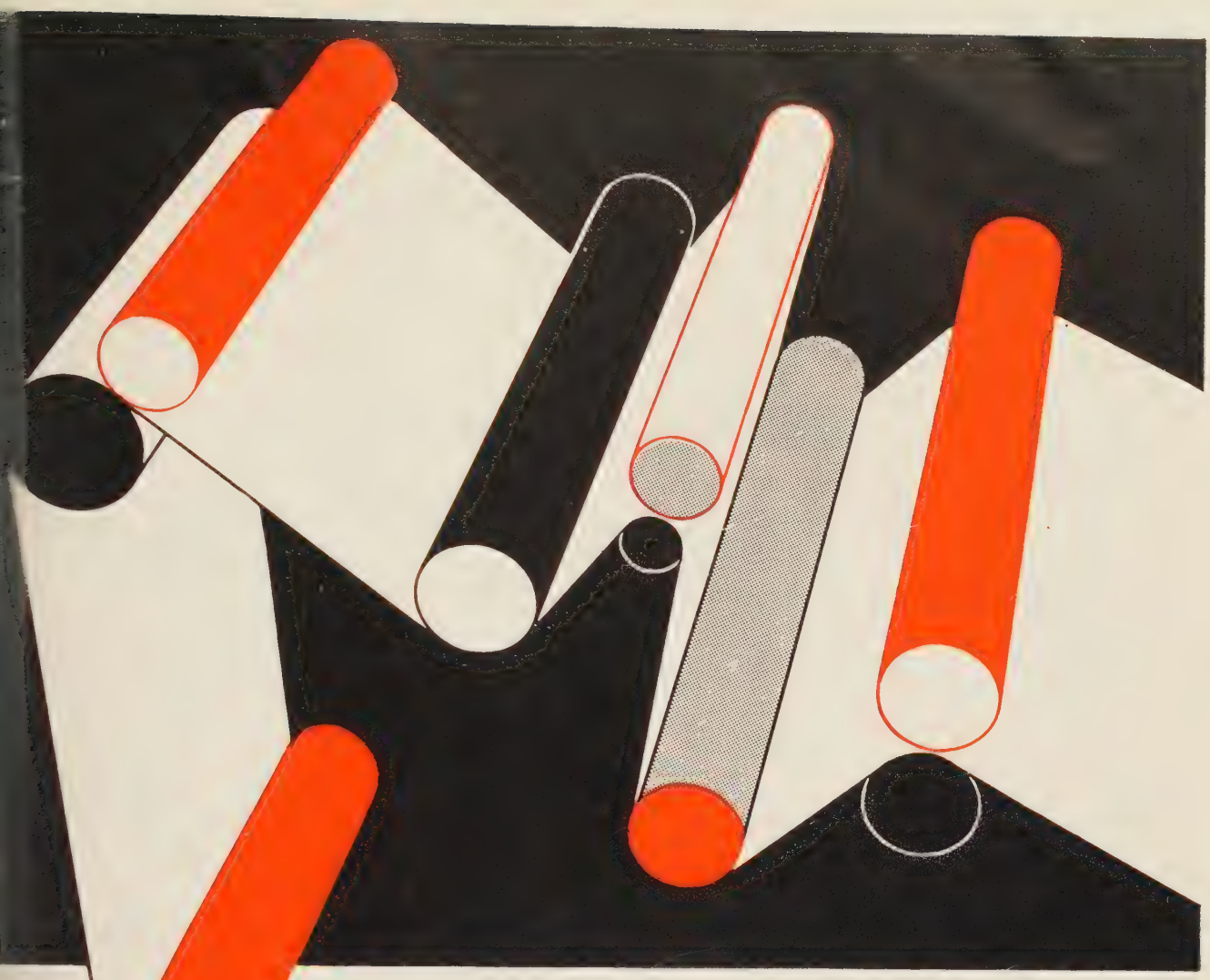


Fig. 6. Gravure coater (left) and gravure offset coat (right)



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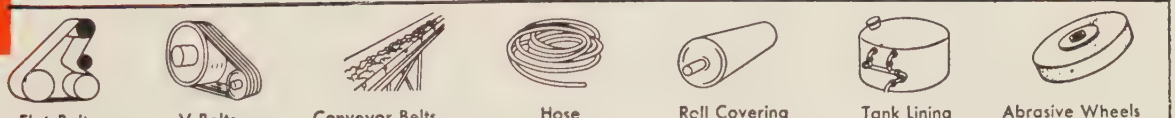

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Although infrared radiation has not been found economical where the solvent evaporation load is heavy, it has been found to be quite effective for more concentrated coatings and for the final stages of drying. Studies have indicated that the longer wavelengths in the infrared region are readily absorbed by cellulose fibers and various plastic materials, which gives a higher energy transfer rate than can be obtained by convection with normal velocities and temperature differences (*2*).

Many plastic coatings require a fusing operation after the coating has been dried. This consists of a short and rapid increase in temperature to melt the coating, with the purpose of smoothing it and forming a continuous film instead of a discontinuous layer of dried particles. Infrared radiant heaters have found considerable use for this purpose.

The infrared-type driers can be arranged in horizontal, arch, or vertical tower designs depending upon the material being dried in the same manner as the air driers.

Still another type of drier is the casting machine, as mentioned briefly under the discussion of knife coaters. With this type of drier the face of the coating is in contact with a large metal drum or an endless driven stainless steel belt passing through a heated housing. The coating either can be applied directly to the drum or belt, or can be applied first to the paper by any of the conventional methods, followed by application to the drying surface. This drying method gives a very high gloss to the finished coating, but is characterized by very high equipment cost and low operating speeds since the solvent must diffuse through the paper in order to be removed.

Another coating method which might be described under the heading of driers is the precipitation coating process which has recently been described (*9*). In this process a resin solution is applied to paper by a conventional coater, followed immediately by the addition of a second solution which causes the resin to become insoluble and to precipitate in the form of a film on the paper. This has been described particularly for hydroxyethyl-cellulose. Thus the water is removed from the resin by chemical action, and a film is formed on the paper itself, followed by evaporation of the water from the surface in a conventional drier.

ADAPTATIONS OF CONVENTIONAL COATING MACHINES FOR HOT-MELT APPLICATION OF LOW TO MEDIUM VISCOSITY RESINS

All of the coating equipment described previously has the obvious disadvantge that the plastic material must be diluted with water or an organic solvent except in the case of the vinyl plastisol compositions. This diluent necessitates the use of some kind of drier for its removal with resultant high equipment and operating costs and space requirements. It was natural therefore, that processes would be sought wherein these solvents would not be required. The first types of machines developed in an attempt to eliminate this extra expense are the so-called hot-melt coaters. These are largely adaptations of the fundamental types, described previously, in which the elements of the machine are heated and the coating is melted to form a liquid of low to medium viscosity.

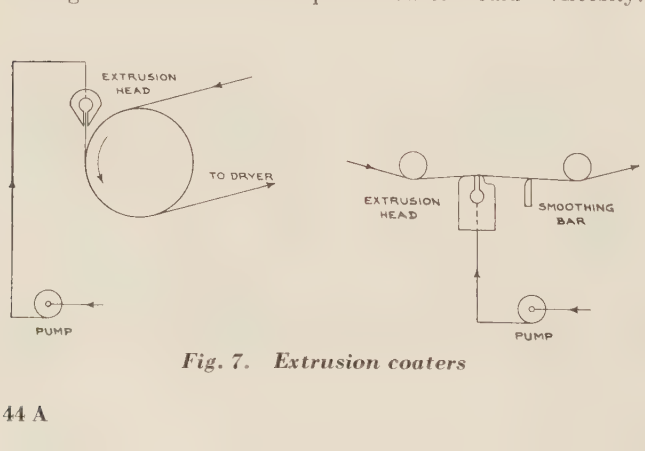


Fig. 7. Extrusion coaters

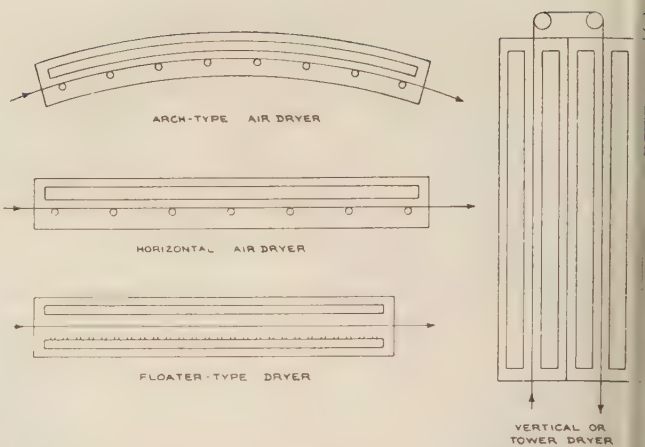


Fig. 8

Paraffin and other waxes and asphalt have been applied t paper by means of hot-melt coaters for many years, but thes materials are not generally considered to be plastics. Th various types of coating units used for hot-melt coating molten plastic materials will be described as follows:

Knife Coaters

Of the types of knife coaters described previously an shown in Fig. 1, two are used for hot-melt coating, one bein the knife-roll type and the other the inverted knife with fu nish roll. The knife-roll type of coater, originally called th rubber spreader, was used in the nineteenth century for appl ing hot gutta percha resin to paper, and this may be the earl est hot-melt application of a plastic material. The advantag of this unit is that it can handle very high viscosities, althoug it suffers the disadvantages of all knife coaters as outline previously. The inverted knife with furnish roll can b equipped with a heated pan to maintain the coating at th proper temperature, but cannot handle high viscosities.

Roll Coaters

The vertical two-roll coater as shown in Fig. 4 has be used for applying various hot melts of relatively low viscos (*12, 15*). With this design the rolls are heated and otherw the machine is operated in the normal manner as on l temperature solutions.

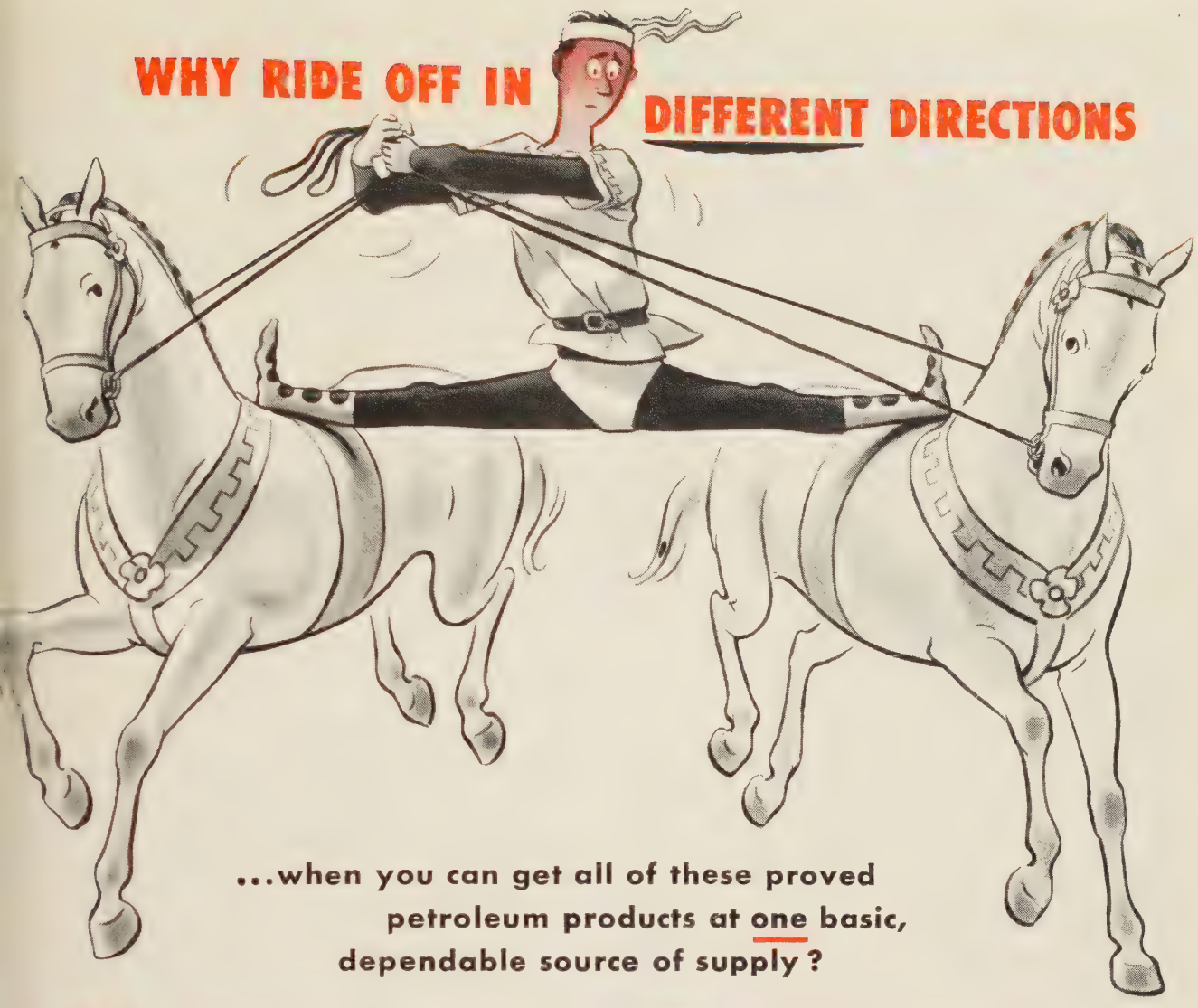
The reverse roll coater as illustrated in Fig. 5 has similar been adapted to hot-melt work by heating the coating roll With the reverse roll coater there is a difficulty which aris with the rubber-covered backing roll supporting the pap If the temperatures are not excessive, a temperature-resisti synthetic rubber compound can be used and the roll can internally cooled to preserve the adhesion between the rubb and the metal core. On some installations where a ve uniform web or a heavy caliper web is being coated, a met backing roll can be used on the reverse roll coater for hot-m service.

Print Roll Coaters

The gravure coater described previously and shown Fig. 6, has been used to a considerable extent for hot-m application of resins (*18*). This coater has the particul advantage of applying a low coating weight which has be accurately metered. The disadvantage exists here, howev that the coating is deposited in the form of a number of d or lines rather than as a smooth film.

The gravure offset method has not been adapted to h melt coating applications because of the necessity of usin resilient offset roll between the gravure roll and the pap None of the common natural or synthetic rubber compoun will withstand the temperature and other deteriorating effe of the hot resin under the conditions necessary for their ap cation.

WHY RIDE OFF IN DIFFERENT DIRECTIONS



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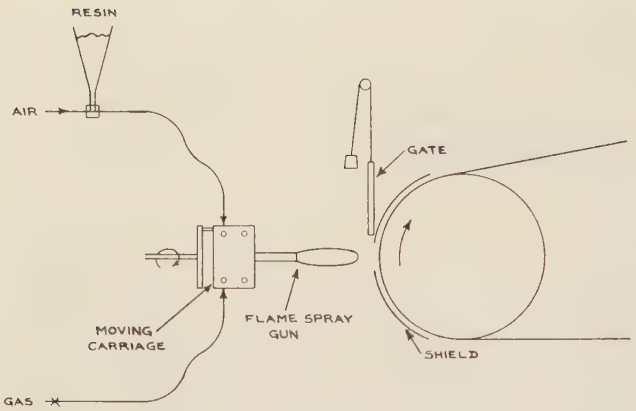

Fig. 9. Hot-melt spray coater

A number of devices have been proposed for smoothing the coating produced by a direct gravure coater. These include mechanical devices such as heated smoothing rolls, bars, and wiping blades, and the application of additional heat to the coated surface (*15*, *16*, *19*, *30*). Thus it has been stated that passing the coated paper beneath infrared heaters or in direct contact with gas flames will give a rapid reduction in viscosity, which will cause the coating to flow into a smooth film, to be followed by a rapid cooling before the paper is dehydrated (*11*, *29*). Re-moistening of the paper is sometimes required after these operations.

Hot-Melt Spray Coaters

A new type of coater for applying resin to paper via the hot-melt principle using a flame spraying technique has been described (*20*). The use of flame spraying to coat stationary surfaces with both plastics and metals, has been gaining increasing use in other fields. This method can be used for coating paper by mounting the flame spray gun on a reciprocating traverse and passing the paper beneath it. Such a machine has recently been described for applying a shellac coating to paper. A sketch of the equipment is shown in Fig. 9. The machine is said to produce a uniform coating but has the disadvantages of low speed and losses of coating material in the overspray.

Cooling Equipment

It is almost always necessary to cool hot-melt coatings before the paper can be rewound into rolls. If the coating is very liquid or tacky it is generally first passed through an air cooling zone where cold air is blown upon paper at high velocity. This serves to set the coating to a point where the cooling can be completed on water-cooled rolls. In other cases the coating can be run directly against the surface of a water-cooled roll without any tendency to adhere to the roll. Since contact cooling is far more effective than cooling by convection, the latter is used only when absolutely necessary.

General Design Considerations

In the design of any hot-melt coating machine, there are numerous problems which arise that are not present in low temperature operations. These problems are principally a result of the fact that metal expands when heated, in proportion to the temperature, and that the viscosity of most plastic coating materials decreases rather rapidly with increases in temperature. It is therefore necessary that the temperature be accurately and uniformly maintained and controlled.

Steam is an ideal medium for heating the various parts of hot-melt coating machines, provided the required temperature is not so high that the pressures would become excessive. Steam has the advantages of a very high heat transfer rate during condensation, and of maintaining constant temperature if the pressure is held constant.

In the case of heated coating rolls, for example, there is a continual loss of heat from the roll body through the journals to the machine frames. If heat were applied at a uniform rate throughout its length, this would tend to make the center hotter and larger in diameter than the ends of the roll. Steam heating automatically corrects this heat loss for the steam will condense more rapidly in the zones of greater heat loss thereby holding the temperature constant.

Another cause of uneven temperatures is the sensible heat absorbed by the paper itself in passing through the machine. Thus the portion of the coating rolls in contact with the paper loses heat at a rapid rate to the paper itself and this tends to give uneven roll diameters and coating viscosities unless compensation is made for this difference.

Preheating the paper is an assistance in this case provided that it does not seriously dehydrate the paper. Preheating also has the effect of causing the coatings to penetrate the paper, which may or may not be desired (*10*).

Some hot-melt coating machines are completely enclosed in a heated housing. This tends to hold the entire machine at a constant temperature and to prevent the undesirable effects of drafts and heat losses through the frames.

A warm-up period is generally advisable before operating these machines in order to allow the rolls to reach equilibrium. Gradual absorption of heat by the frames causes them to expand also, but at a slower rate. This changes the spacing of the rolls, and the frames should therefore also be at equilibrium. Insulating the roll journals from the frames will minimize this effect.

If the required temperatures are too high for the available or safe steam pressure, it then becomes necessary to use other means of heating. These means would include hot oil or fluid circulating systems and direct electric heating by means of resistance heaters (*22*). The oil system should have a high circulating rate to minimize the temperature drop through the machine. Electrical systems require elaborate and expensive control equipment, and this becomes particularly complex in attempting to heat revolving rolls electrically.

Other means which would be available but which are not commonly used for heating hot-melt coating machines are the low pressure high temperature vapor systems such as Dowtherm, and the molten salt or liquid metal fluid heat transfer systems.

The melting and heating of hot-melt coatings requires specialized equipment to deliver the materials at a uniform temperature and flow rate to the coating machine. The solid resin mixture is generally melted in a heated tank, and conveyed by means of a positive displacement pump through heated lines to the coater.

It is convenient to use the same means of heating for the tank and lines as for the coater, namely, steam, hot oil, electricity, etc. The lines should be equipped with drains to permit emptying during shutdowns, and with clean-out flanges in the event of blocking by unmelted or highly polymerized impurities (*4*).

NEW EXTRUSION-FED EQUIPMENT FOR HOT-MELT APPLICATION OF HIGH VISCOSITY RESINS

Many of the recently developed resins having properties

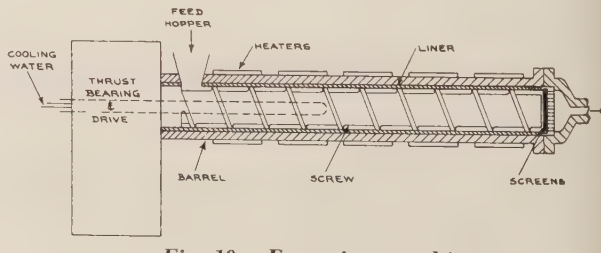

Fig. 10. Extrusion machine

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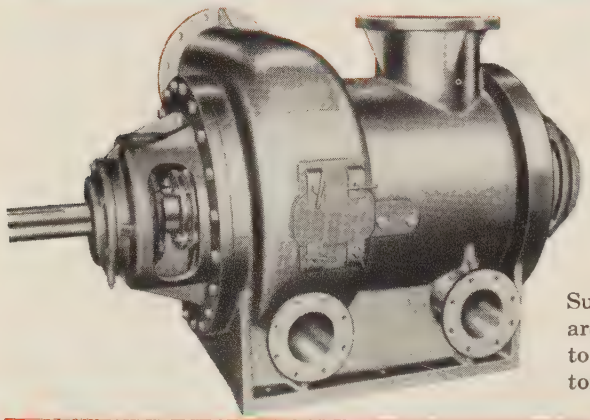

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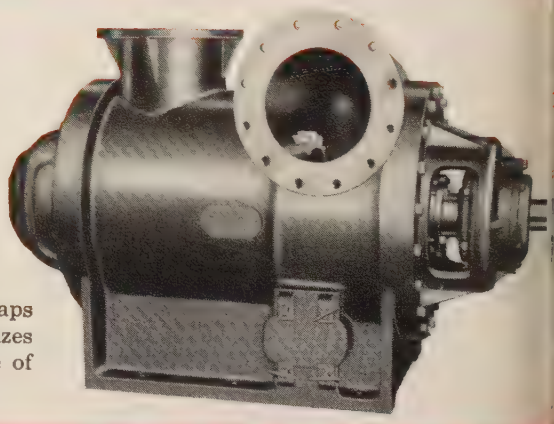

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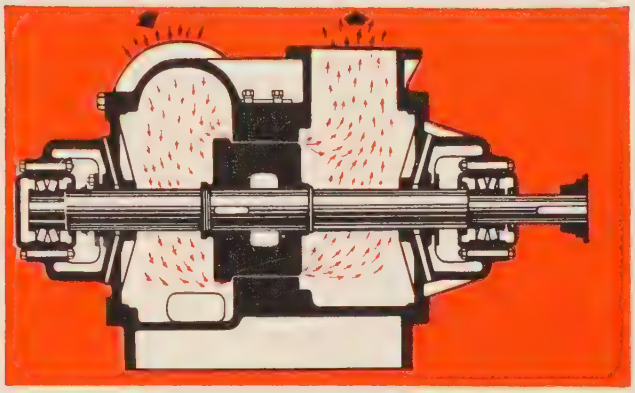

Cut away view showing operation of Sutherland Breaker Trap.

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desirable for paper coating have very high viscosities in excess of 100,000 cp. In most cases the viscosity cannot be reduced further by increasing the temperature, because decomposition or oxidation would be rapidly accelerated. The application of this type of resin can be considered as consisting of two steps. The first consists of heating the resin to the softening point and removing air and foreign particles from it, and the second consists of applying the resin to the paper in the form of a continuous film or coating.

Extruders

Most resins are poor conductors of heat, and when cold are generally supplied in granular or powder form. Bulk materials in this form generally contain about 50% voids by volume. The plastic extruder has been found to be the best machine for taking these plastics from the cold granular state and delivering them in a continuous stream of pure plastic material at the desired coating temperature.

A typical plastic extruder is illustrated in Fig. 10. The resin is drawn from the feed hopper by means of a rotating screw and passed through a heated steel barrel. The action of the screw compacts the plastic to displace all air from the material, and the plastic is heated by contact with the heated metal walls of the barrel.

The design of the screw varies widely depending upon the type of resin being handled. The so-called metering-type screw is generally used for materials which are extruded for the purpose of coating paper. This screw has a uniform pitch and depth for most of its length and for a short section near the discharge, the depth is decreased while the pitch is maintained constant. This design gives a more uniform flow rate and uniform heating and plasticizing of the product. The screws are frequently bored for water cooling to prevent overheating in the feed section, and to control the temperatures for the full length in the case of materials which generate frictional heat in the barrel.

For heat-sensitive materials, such as saran, a so-called torpedo-type screw is used. This includes a smooth section with no flights and with a close clearance between the screw and barrel near the discharge end. The purpose of the torpedo is to give a high rate of shear and mixing and low retention time during the final heating period.

The exterior surface of the barrel is heated by steam for plastics which require low temperatures or for those which require very close temperature control, such as saran. Intermediate temperatures are frequently supplied by oil heating systems, whereas high temperatures required for polyethylene and nylon are accomplished by electric heating with individual controls on several zones of the barrel.

A filter consisting of a pack of stainless steel screens supported by a perforated metal plate is installed at the discharge end of the extruder. This serves the dual purpose of removing foreign particles and of creating a back pressure necessary for the proper functioning of the screw.

For handling vinyl resins and similar materials which generate frictional heat, cooling coils or air cooling channels are provided on the barrel to prevent overheating and thermal decomposition.

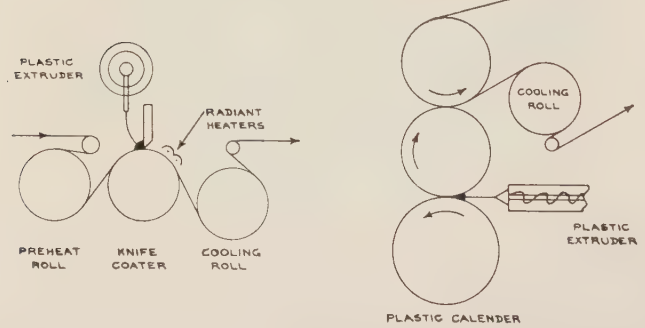

Fig. 11. Extruder-knife coater (left) and extruder-calender coater (right)

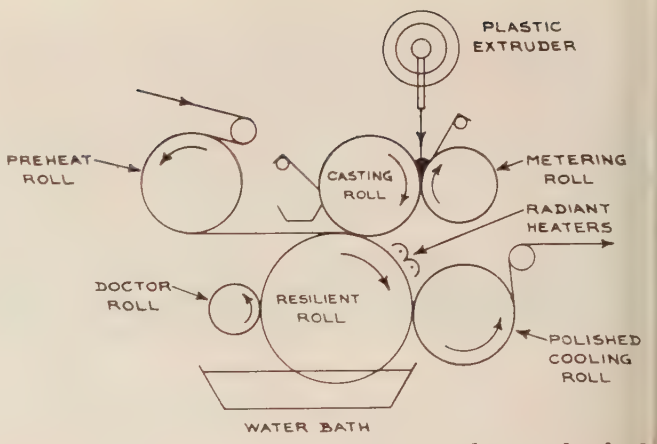

Fig. 12. Hot-melt reverse roll coater with extruder feed

After leaving the screen section the resin continues to flow under the pressure created by the screw, through a heated adapter section to the point of discharge into the coating machine. This may be one of a number of special dies, all heated, depending upon the type of coating machine being used. There are several units which can be used to apply these extruded high viscosity coatings to paper, as follows.

Knife Coater

The so-called knife-roll coater, in which the paper is supported beneath the doctor knife by means of a driven roll, can be used to apply high viscosity extruded coatings, as shown in Fig. 11. For lower temperature types the knife can be heated by steam and a rubber-covered backing roll can be used. The continual travel of the relatively cool paper over the backing roll prevents scorching of the rubber.

For higher temperature operation electrical heating is used for the knife and a metal backing roll should be used. This roll can be heated slightly (but not to the point of damaging the paper) in order to improve control of the coating thickness.

On narrow machines the coating can be delivered to the bank ahead of the knife in a single stream from the discharge of the extruder, but on wider machines a heated die or distributing header is advisable.

Although this machine is being used commercially on medium molecular weight polyethylene and has been tested successfully on other resins, it has the disadvantages of all knife coaters with regard to inaccurate coating thickness control, streaks, etc.

Calenders

The calender coater was originally developed for coating fabrics with rubber. It consists of a stack of three or four heavy chilled iron rolls with a ratio of face to diameter generally less than 3 to 1. These calenders have been more recently adapted for producing plastic film and in some cases have been used to apply plastic coatings.

The plastic is first heated and plasticized in either a Banbury mixer, a two-roll rubber mill, or an extruder. It is then formed into a sheet between the first pair of rolls under very high pressure and is applied to the paper between the second pair of rolls. This process is seriously limited for coating paper because of the high cost of the equipment and the fact that the minimum coating thickness is in the range of 2 to 4 mils. Figure 11 illustrates a three-roll calender with extruder feed which has been used to coat paper with vinyl resin, saran, and other materials.

Reverse Roll Coater

The extrusion-fed reverse roll coater does not have the dis-

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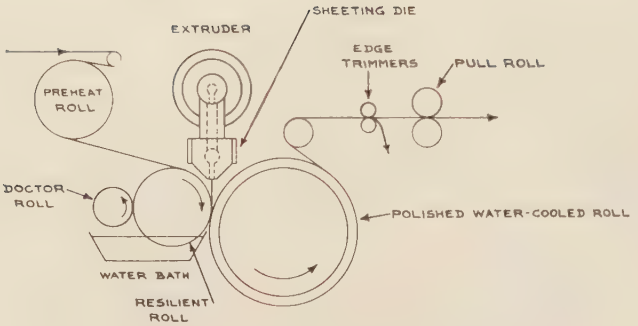

Fig. 13. Extrusion-lamination coating machine

advantages of the knife coater just mentioned, although it cannot handle quite as high viscosities. This machine is shown in Fig. 12.

It will be noted that the machine consists fundamentally of a conventional reverse roll coater with an extrusion machine for melting and feeding the resin. A preheating roll has been added to warm the paper together with a water-cooled polished roll to cool and smooth the coating. One of these machines was first built several years ago to test its usefulness for polyethylene coatings. It was found that polyethylene of molecular weight as high as 14,000 could be applied in thin uniform coatings on this equipment. Higher molecular weights gave rough heavier coatings because of their higher viscosity, and the correction of this condition by the use of higher temperatures resulted in excessive oxidation. In any event, the adaptation of such a process to polyethylene on a commercial scale would probably require blanketing the coating machine with inert gas to minimize oxidation of the resin.

Since the ideal grades of polyethylene for coating paper have a molecular weight on the order of 20,000 or higher, this process has been discarded for this resin in favor of the direct extrusion-lamination process to be described later.

The extruder-fed reverse roll coater has advantages, however, for resins which are heat sensitive rather than subject to oxidation, such as saran, because of its low retention time. Saran has been successfully coated on paper on a small scale with a unit of this type. Steam heating is used for both the extruder and the rolls of the coater in order to give accurate temperature control.

With very high viscosity resins the metering roll of the reverse roll coater is operated at an extremely slow speed or is held stationary to keep the inventory in the fountain at a minimum. The doctor blades are heated to give uniform doctoring and the various heated parts are insulated from the frames to make possible the maintenance of accurate control of the roll clearances.

A flash heater can be used to raise the temperature and reduce the viscosity of the coating for an instant before it is pressed against the smooth water-cooled roll, as shown in Fig. 12.

This type of equipment should be adaptable to other resins such as vinyl compounds which are not too high in viscosity and are not subject to rapid oxidation at the application temperature.

NEW EQUIPMENT FOR DIRECT EXTRUSION-LAMINATION PROCESS OF HIGH VISCOSITY FILM-FORMING RESINS

Although this equipment might logically be included under the preceding heading, it will be discussed here as a separate item, because it is considered to be a new development of major importance, which has been widely adopted during the past two years. An extrusion lamination machine is shown in Fig. 13. This process was developed specifically for high molecular weight polyethylene resins (*5*) and has since been found adaptable to nylon and S-polymer resins.

As can be seen in Fig. 13, the resin is first melted and compacted in an extruder of the type described previously. The extruder discharges into a horizontal sheeting die which forms the resin into a thin film. The opening of the slot at the bottom of the die is commonly set at from 0.012 to 0.020 in.

The hot extruded film is laminated onto the paper to form a coating in a specially designed film laminator. This unit consists of a water-cooled roll and rubber pressure roll located directly beneath the sheeting die.

The paper may be preheated if it has a high moisture content or a high weight per unit area, such as board. The laminating pressure varies from 60 lb. per in. on soft rough materials such as board, to 100 lb. per in. for smooth hard materials such as foil and glassine. The hardness of the rubber roll similarly varies from 60 to 90 durometer depending upon the materials being coated.

It might be said that most of the elements of this machine including the extruder and the paper handling equipment are of conventional design, but the two key features which contribute to the success of the process are the sheeting die and the water-cooled laminating roll. These are illustrated in Fig. 14. It will be seen that the die consists of a horizontal tube which can be fed at the center or at one end. The material discharges vertically downward through a slot and is formed into a film of precisely controlled thickness by means of adjustable jaws at the bottom of the slot. The die is electrically heated with temperature controls on individual zones to maintain uniform temperature throughout its length and the jaws are adjustable by means of closely spaced screws.

Although it might seem at first glance that pressure drop of the plastic through the die would cause the coating to be thicker at the center than at the ends, it has been found that uniform film can be produced as wide as 120 in. with a die of this same cross section. Calculations of pressure drop of the highly viscous molten plastic through the die have indicated that, by selecting the proper dimensions for the tubular hole and vertical slot, the pressure drop in the former can be made negligible compared to the latter, and uniform flow from the slot can be obtained over considerable lengths.

The problem in the design of the water-cooled roll consists of building adequate cooling capacity into the roll to remove all of the heat in the polyethylene coating on a single roll. With some hot-melt coatings the material can be cooled at high speed by passing it over a series of rolls, but in the case of polyethylene it has a strong tendency to adhere to the metal roll unless it is relatively cold. To obtain good speeds, it is therefore necessary that all of the heat be removed by a single cooling roll.

This problem is approached by first determining the total heat to be removed, which is a function of the total extrusion rate and total heat content of the plastic at the extrusion temperature, and is independent of machine speed and coating

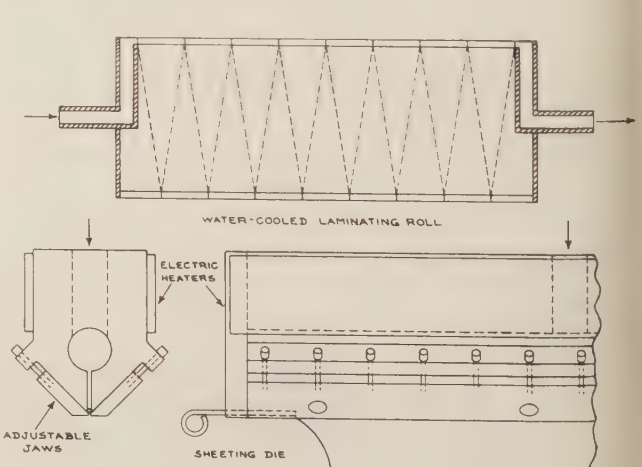

Fig. 14

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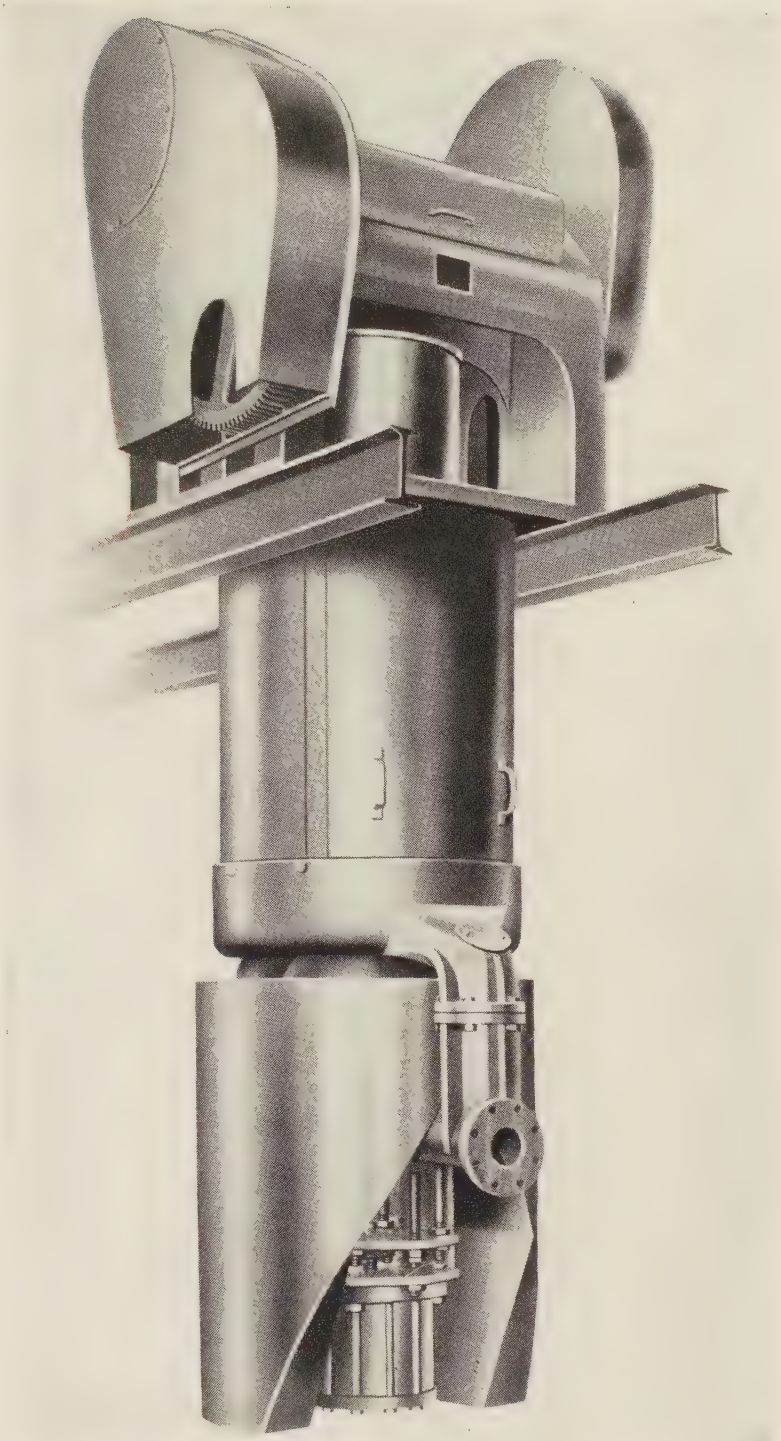

A Jackson & Church Zenith Medium Press typical for use in de-watering high density pulp crumbs.

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thickness as such. The volume of cooling water required to remove this heat with a minimum temperature rise, preferably less than 5°F. per pass through the roll, can then readily be calculated.

The resistance to heat transfer from the plastic to the cooling water includes: (1) the low thermal conductivity of the plastic, (2) the metal wall of the cooling roll, and (3) the water film coefficient and scale factor. The first item is not significant on thin coatings, and the second indicates the use of a thin metal shell of good thermal conductivity. The water film coefficient is the most critical of the factors and requires the use of a double shell roll with spiral baffling, as shown in Fig. 14, to give a velocity of at least 5 f.p.s. Eventual build-up of rust and scale may make chemical cleaning of the roll interior necessary on older machines in order to maintain capacity.

A water recirculating system is recommended for the cooling roll in order to give a high internal velocity and low temperature rise without wasting water, and to permit temperature control of the roll surface.

Since it has been stated that the die is set at an opening of 0.012 to 0.020 in., it is obvious that the coating must be stretched to obtain the desired low finished thickness. The speed of the paper is, therefore, considerably greater than the speed of the film emerging from the die. In actual practice the opening of the die has no effect on the thickness of the coating provided the opening is uniform. The coating thickness is then a function of the paper speed and the total extrusion rate.

In addition to the die design and cooling roll design several factors are important in obtaining the proper quality of the coated paper. The surfaces of the die must be clean and well honed at all times in order to obtain a smooth uniform coating free of streaks. The machine must not be stopped for more than a minute or two at any one time without cooling the die rapidly in order to avoid oxidation of particles at the face of the die.

In order to obtain maximum adhesion of the film to the paper it is necessary that the film be at a high temperature so that the plastic is tacky. In order to produce this temperature, the last zones of the extruder and the sheeting die itself are heated to a temperature in the vicinity of 600°F. The film must then be transferred to the paper with a minimum loss of temperature. For this reason the die is made with its lowest surfaces in a V shape so that it will fit between the laminating rolls. This reduces the distance and time lag during which the film can lose heat, and also tends to block cold air currents which naturally follow the two moving rolls. In addition the tangent plane of the film to the nip of the laminating rolls must be adjusted so that it contacts the nip preferably tangent to both cylindrical surfaces. If the film contacts either the paper or the water-cooled roll before the pressure is applied, it is chilled very rapidly and the adhesion is reduced or completely lost. Since the film does not necessarily follow a straight line path at very high speed, and since the extruder and die move slightly when they are heated, it is advisable that the positions of the laminating rolls be adjustable to permit maintaining the proper contact tangent under all conditions (*24*).

Obtaining proper adhesion of the coating has been one of the more difficult problems in operating this process, and in actual experience maintaining the film temperature has been found far more critical than such factors as cooling roll temperature, laminating pressure, paper preheat, rubber roll hardness, etc. Thus a 1-mil film extruded at 550°F. will cool 100°F. in $^1/_2$ sec. in contact with cold air, and in 0.004 sec. in contact with a cold surface. The time is correspondingly less on thinner coatings. These figures indicate the critical nature of the requirements of locating the die close to the nip and of maintaining the proper tangent plane between the films and the rolls.

One disadvantage of this process as it is now operated is the fact that the extruded film thickens at the edge when it is stretched. This means that about 1 in. of paper containing about $^1/_2$ in. of plastic coating must be trimmed from each edge of the web as it leaves the coater, resulting in a considerable waste since the plastic cannot be recovered from the paper.

A recent development proposes that the film be extruded wider than the paper and that the thick portion be trimmed off as pure plastic, free of paper, which can then be re-used. The problem thus far has been in preventing the plastic which projects beyond the paper from sticking to the rubber-covered laminating roll. Experience with embossing of unsupported plastic film has indicated that this adhesion can be prevented by cooling the rubber roll with a water bath followed by a doctor roll to remove the excess water. This principle has been in regular use for some time on vinyl and polyethylene film embossers.

It is expected that this practice will be introduced in the future to eliminate the costly edge trim and in fact is already being used where materials such as cellophane and aluminum foil are being coated by the extrusion process, in order to prevent overheating of the rubber roll as well as to reduce trim losses.

A recent proposal that a detergent in the water bath improves the wetting and cooling action and reduces the adhesion problem is also expected to be introduced commercially.

Thus far the extrusion-lamination process has been used largely for polyethylene, although it has been found practical for nylon and S-polymer resins. The principal obstacle to the use of other resins is their thermal instability. Although the average inventory time in the machine is low, a zone of long hold-up exists in the ends of the sheeting die. This has been found to cause decomposition of materials, such as saran and polyvinylchloride resins, with the result that they cannot be handled successfully in this equipment at the present time.

Studies are under way to develop dies of improved design which would permit handling these and other heat-sensitive resins on this equipment. If these studies are successful, it will greatly widen the usage of this type of machine, which has numerous advantages in both equipment and operating costs over previous types of coating units for plastics.

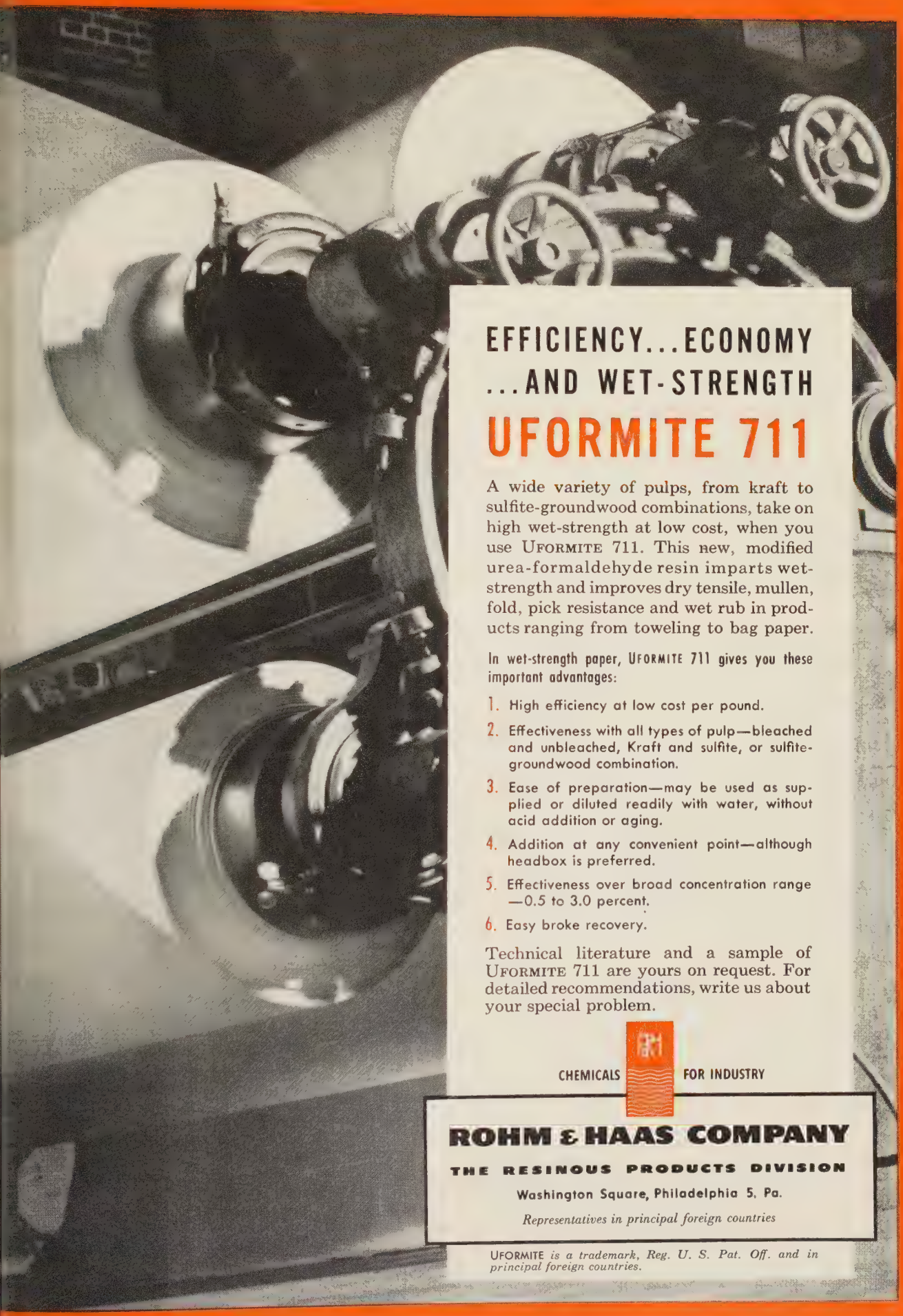
Speeds as high as 1000 f.p.m. are obtainable on this equipment and the actual limit is not yet known. It is believed that the ultimate limit is based only upon the extruder capacity, and it is expected that several thousand pounds per hour of resin could be extruded and applied as a coating.

It is also within the realm of possibility that very wide sheeting dies could be fabricated. If the demand for a particular grade of polyethylene or other plastic-coated paper should increase sufficiently, it would then be feasible to install equipment for applying this coating directly on the paper machine without loss of machine capacity.

The range of coating thicknesses with this process is in the vicinity of $^1/_2$ mil to almost any thickness desired. Experiments are under way to produce thicknesses on the order of 0.0002 to 0.0003 in., but these are not yet being produced commercially, and in any event many of the properties of the resin are lost at such low thicknesses.

CONCLUSION

To summarize, it can be stated that the coating of paper with plastics is an old art which has seen important new developments in recent years. The early methods, many of which are still used, involve dissolving or emulsifying plastics with water or solvents and applying them on equipment which had been in use for many years on aqueous inorganic coatings. For economic reasons and because of developments of new plastics, coating methods were then sought and developed which made use of the thermoplastic rather than solubility properties of the plastics. The conventional coating ma-



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chines were modified to permit high-temperature operation and to melt the plastic to a relatively low viscosity liquid. More recently the extruder has been used to melt and to compact the higher viscosity plastics, and the plastic has been formed into a continuous coating on the paper by means of the knife coater, reverse roll coater, or calender, or by means of a sheeting die and laminator.

In the future, it can be expected that the trend will be away from solvent and emulsion coatings requiring expensive drying equipment toward the hot-melt and higher viscosity direct resin application. Since viscosity is generally a function of the degree of polymerization and since the higher polymers seem to have superior coating properties, the trend can be expected to be in the direction of even higher viscosities. The direct extrusion lamination process and the extrusion-fed reverse roll coater should therefore find increasing application for future resin developments.

As the various chemical companies increase their capacity for producing resins and, it is hoped, reduce the cost of these resins, the field of plastic-coated paper should continue to expand. Ultimately, plastic-coated papers may be produced directly on the paper machine by the direct-extrusion lamination process, just as clay-coated printing papers are now widely produced on the machine.

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CHAIRMAN: The next speaker is an old friend of mine—in fact, my old colleague. I know Mr. Davidson has done considerable work in the field of adhesives particularly in the field of envelope manufacture and I think you will find his talk very interesting and thought-provoking. Mr. Davidson is a graduate of Montana State College and received his Doctorate at Columbia. From 1925–29 he was at Forest Products Laboratories in Madison and since has been with the Mellon Institute of Industrial Research.

From Art to Science in Envelope Manufacturing

P. B. DAVIDSON

ANY discussion of the application of high polymers to paper technology is something like carrying coals to Newcastle because the whole subject of papermaking is the art and science of high polymers. The art consists of the experience and know-how of putting a sheet of paper together properly and it covers up those parts of the process that are not controlled by scientific knowledge. There are so many controversial subjects in this science of paper technology, so much confusion of opinion with fact, so much we have yet to learn that the author, for one, is rather humble in venturing to discuss even one or two small fields in which science has been applied.

The more we study paper the more we realize that we are working with materials that are highly surface-active. They are either colloidally dispersed or their behavior depends upon the same chemistry that determines colloidal stability. Among the systems that are generally classed as colloidal are emulsified rosin, alum floc, various starch dispersions, and animal glue sols. The surface-active materials are, first and foremost, cellulose fibers, then the various fillers, which may be clay or titanium dioxide. All these must be combined in what we call a "furnish" to give a sheet of paper that meets the exacting demands of the customer. The interior sizing of a paper is accomplished by breaking the rosin emulsion with aluminum sulphate and the precipitated rosin must adhere to the cellulose in particles not larger than 2 mu. The retention and proper precipitation of these particles are aided by the aluminum floc that forms in the reaction. The so-called protective colloid action of starch, glue, casein, dispersions of various cellulose and starch derivatives, melamine, and urea-formaldehyde resins is also used as insurance against poor sizing. To oversimplify the sizing process, negatively charged rosin particles are stuck onto negatively charged cellulose fibers with positively charged alumina floc. The success of this process is based upon the assumption that the cellulose fibers are always the same, in spite of known variables in the cooking, washing, bleaching, and subsequent beating. Most of the work on papermaking fibers has been concerned with retaining the original strength of the cellulose. Too little is known about the surface chemistry of celluose. It is recognized that the chemical history of a cellulose fiber determines its behavior as a papermaking material, but in what way and to what extent? The chemical history of a sulphite pulp and a rag stock are so different that there is little wonder that significant differences are encountered in the beating and engine sizing of the two types of fibers.

For the author to expound upon the science and technology of papermaking may be a bit presumptive, so let us confine our attention to two or three practical applications of the science of high polymers to paper. Although, at first glance, they may appear quite irrelevant, they are basically related through the property of surface activity of the paper and the materials applied to it.

The first of these has to do with dextrin gums applied as adhesives to envelopes. As you well know, a dextrin is not a distinct compound like sucrose, but an indefinite collection of lower carbohydrates. They are made by either enzyme or acid hydrolysis of starch and the degree of hydrolysis determines their properties. The envelope converter uses two types of dextrin. One is directly dispersible in hot

P. B. DAVIDSON, Senior Fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa.

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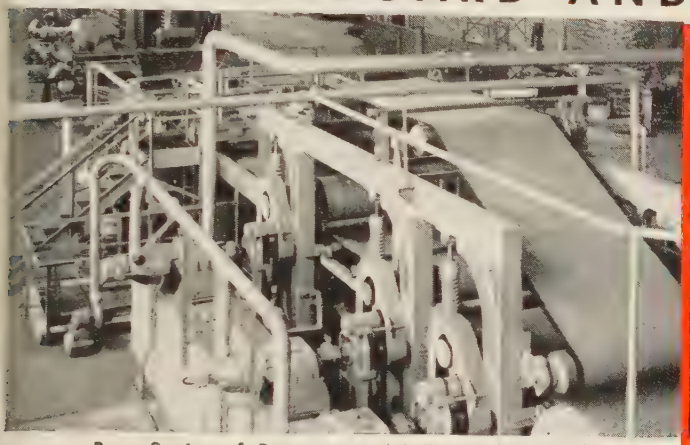
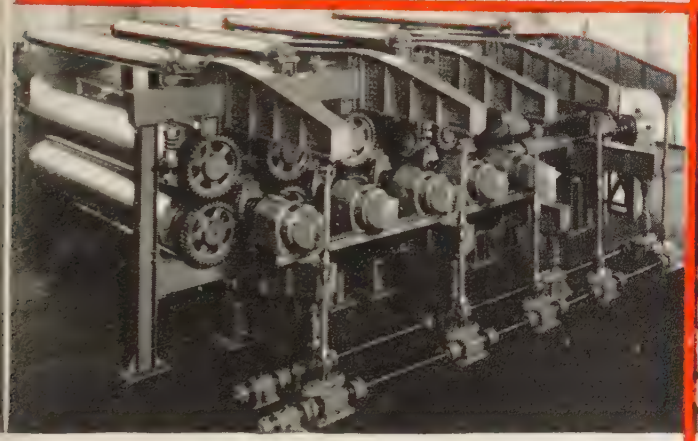
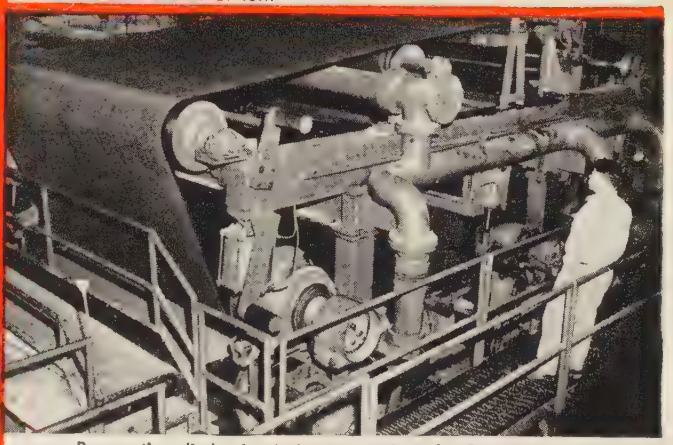


Press Section of Downingtown Wallboard Machine for making hardboard at Oregon Lumber Co.

Head box and Fourdrinier type forming section of the machine shown at left.



Cantilevered press section of a new wallboard machine making either hard or insulating board.



Pneumatic cylinder loaded press section of a Downingtown Wallboard Machine showing two suction press rolls.

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water and the other requires further hydrolysis in hot aqueous suspension. The former is the "remoist gum" and the latter the "body seal gum." The remoist gum becomes viscous when cooled and the body seal gum sets to a white gel. The problem of the envelope converter is how to make satisfactory adhesives out of these gums. To make things more interesting, dextrins from different starches are not alike. Potato starch produces a dextrin that, if handled very carefully, makes a good envelope gum. However, tapioca dextrin has long been the preferred material. It is much more difficult to prepare a satisfactory envelope gum from cornstarch than from these root starches. So far, the Good Lord is the only one who knows the complete answer to this, but a difference in configuration of the cornstarch molecule, which contains a higher percentage of linear molecules than tapioca or potato starches, appears to be a contributing factor. Also the greater tendency of these linear or A-fractions from corn to retrograde may have some bearing on this problem. The A-fraction from tapioca is more stable to such insolubilization.

The "stickum" on an envelope must have three rather obvious properties. It must be sufficiently tacky when wet to hold the flap to the body of the envelope while the gum dries. It must possess adequate adhesion to the paper, and it must have high cohesive strength. This sounds very simple, but what is adhesive strength and how does one improve cohesive strength and tackiness? Too often it has been our unfortunate observation that dextrins seem to resent help from other materials. If a so-called "improver" is added to a dextrin gum the result is not an additive function of the dextrin and the "improver" but a subtractive one. The resultant mixture is worse than the original dextrin gum.

Both the adhesive and cohesive strengths of a remoist gum depend upon the degree of hydrolysis of the starch. If the hydrolysis has been too drastic and the "degree of polymerization" reduced too much, a gum results that has both poor adhesive and cohesive strength. It is self evident that a gum that appears satisfactory for a cheap paper would not form a good seal with a strong one. A good seal is judged by its ability to pull out fibers from the paper when an envelope is opened. Thus a strong rag paper has a higher "peeling strength" and requires a stronger adhesive than a wood pulp paper. In testing remoist gum seals, either manually or with a tensile testing machine, there are few borderline cases between good and bad seals. The paper is either torn and the surface fibers pulled off or the gum itself fails, leaving a layer of dried gum on both the body and the flap of the envelope. In the first case the gum is adequate for the paper used. In the second case it possesses satisfactory adhesive but poor cohesive strength.

In the 5 o'clock rush to get the mail out, the property of tackiness is very important, particularly to the user of envelopes made of rag paper. When a gum is remoistened, it must imbibe water rapidly to produce a tacky adhesive. In 2 or 3 sec. the remoistened gum must have gained sufficient tackiness to hold the flap to the body of the envelope and resist the natural tendency of the paper to curl. The common habit of secretaries to sit on the sealed letters has only one advantage; the pressure on the seals prevents the curling of the paper and the breaking of the seal before it is dried. The human being seems to possess a psychosis relative to remoistening an envelope gum. We have yet to find anyone who really enjoys doing it. If the gum is flavored with oil of wintergreen some people prefer raspberry flavor. Others are immediately suspicious that the flavoring is used to cover up something vile or poisonous. The net result is that they do not remoisten the gum sufficiently. Many customer complaints are based upon psychology rather than on the technology of dextrins. The use of remoistening gadgets is not the complete answer for office help and mail clerks do not seem to realize the necessity for keeping water in the applicator and keeping the applicator clean so that it can deliver moisture to the gum. The best gum ever prepared will not function properly if it is not remoistened.

The body seal gums also offer some interesting problems. The dextrins used for these gums are lightly roasted, white dextrins which must be further hydrolyzed with acid in aqueous suspension at an elevated temperature. The resulting gum sets to a gel when cooled unless a "fluidifying agent" is present. The commonly used fluidifying agent has been cane sugar and generally the manufacturer added it to the dextrin and sold the mixture under some mysterious code number or trade name.

Such gums have the unfortunate property of discoloring during hot, humid months of the summer. It was found that this discoloration was caused by the reaction of reducing sugars derived from hydrolysis of the sucrose with the proteins, such as glue size, in the paper. This is the same reaction that takes place in aged marshmallows. In fact it was the work on marshmallows that led to the production of nondiscoloring envelope gums. In the case of the envelope gums the solution of the problem was relatively simple, once proper diagnosis was made of the problem. The chief source of the reducing sugars was the sucrose. This was substituted by a material that was stable to hydrolysis and did not produce aldehydes to react with the protein, glue. There are several families of organic compounds that can be used as "fluidifying agents." The most commonly used material is urea, the amide of a carbonic acid. However, not all soluble amides of monocarboxylic acid can be used for the preparation of a nondiscoloring gum. Two exceptions are formamide and the amide of gluconic acid.

This action of fluidification of dextrin dispersions is a most interesting subject. We have built several theories to explain it. One of them involved the rebalancing of osmotic forces when a fluidifying agent was added or, putting it another way, the competition between the agent and the dextrin for water of imbibition which prevents the dextrin from setting up a gel structure. These are nice theories but, in the last analysis, we must admit we are not sure of the real answer.

The old saying that there are two sides to every question is certainly true in envelope converting. The properties and requirements of the adhesives have been briefly outlined but little has been said about the other side of the question, the paper. It has long been recognized that what we think of as adhesion is a function of the interfacial surface tensions. There is no way we can directly measure such interfacial tension between a dextrin gum and a paper. However, the property we are concerned with, the adhesion tension of a liquid on a solid, has been defined as the difference between the surface tension of the solid and the interfacial tension of the solid against the liquid. This has been equated to the surface tension of the liquid times the cosine of the angle of contact between the liquid and the solid. Here we have measurable factors to determine the adhesive properties of a gum on different papers or of different gums on a standard paper.

The question then arises concerning the possible alterations in paper manufacture that would produce better sealed envelopes. One possibility was found in some work on blueprint paper manufacture. The problem here was to surface or tub size the paper so that the light-sensitive blueprint coating would completely and evenly cover the paper without leaving small uncoated areas that developed into white spots in the final prints. This brings us to the chemistry of another high polymer, proteins and specifically, gelatin. This white spot problem was another involving wettability of a solid by a liquid and if the adhesion tension of the coating solution on the glue sized paper or of the glue size and base paper was sufficiently high, complete coverage would result. Cross sections of the blueprints were examined under the microscope and it was found that in many cases where white spots had been bisected, there was no glue size at that place. Obviously two problems were presented: the wetting of the paper by the glue size and the wetting of the sized paper by the coating solution.

One attempt to solve these was with the use of wetting

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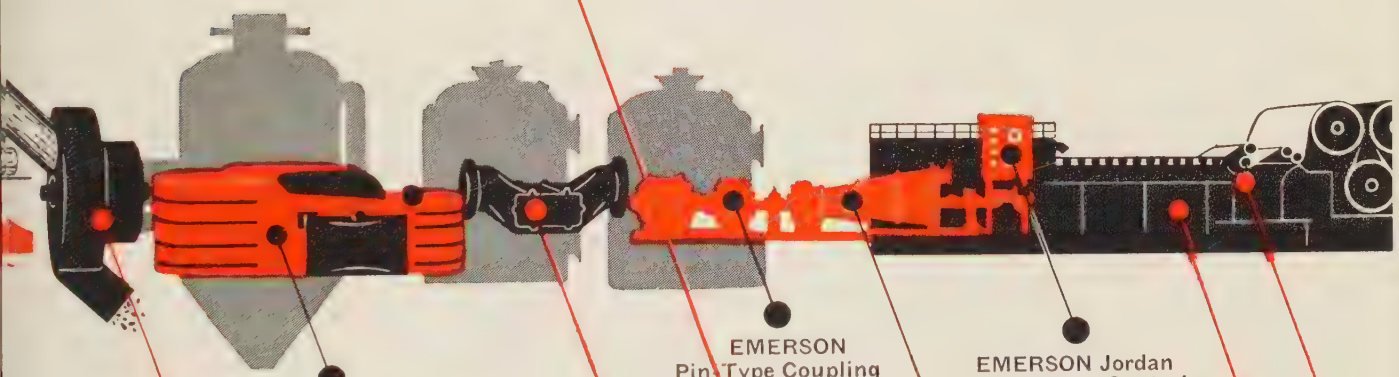

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agents in the size. It was found that cationic wetting agents eliminated the white spots, nonionic wetting agents were less effective but anionic agents increased white spotting. Here was a case where a wetting agent acted in reverse. It acted as a repellent for an aqueous system rather than as an assistant to wetting.

A more satisfactory method was one that took advantage of the ionic properties of the protein, or animal glue. A series of gelatins was prepared at pH's varying on either side of the isoelectric point. These dispersions followed the characteristic pH-viscosity curve that shows a minimum viscosity at a pH of 4.7. The viscosities were measured with an Ostwald pipet. A small hand-operated size press was made from a rubber wringer roll and a brass roll, with a system of levers that allowed varying pressures on the rolls. The "size tub" was a metal pan resting in a larger pan which, in turn, was supported in place by an electric hot plate. The larger pan served as a water bath to keep the glue size at the proper temperature. The paper samples were immersed in the glue in the small pan, a bent glass rod was passed over the surface of the paper to remove any adhering air bubbles and the excess glue was squeezed off by passing the soaked sheet through the nip of the rolls. The papers were then air dried and calendered. Samples of paper sized at each pH condition of the glue were coated with blueprint solution and then printed and developed. Glues near the isoelectric point allowed bad white spotting while those on either side of this point were progressively better, the farther the pH was from 4.7. At a pH of about 2, excess acid was present in the size and the papers were no longer well sized nor permanent with respect to their strength, that is, their folding endurance.

Cross sections from these papers indicated that the pH condition of the glue had an influence upon the wetting of the paper by the glue in the tub sizing operation. If the glue was in the ionic condition, either anionic or cationic, it produced a more complete and unbroken coverage of the fibers than when it was in the nonionic condition. This signified better wettability and thus greater adhesion tension of the glue for the paper. To look at it in another way, the glue in the ionic condition served as its own wetting agent. The position of the glue in the paper was determined by a staining method. It was found that if mercurochrome was flowed under the cover glass, the cross-sectioned paper turned red, but that only the glue retained this color after the section had been washed several times with water. This was accomplished by applying a drop of water at one edge of the cover glass and then pulling it through to the other side with a strip of blotter.

Whether these changes in pH of the glue size also affected the wettability of the sized paper by water or an aqueous system was determined by measurements of the contact angle of water on the differently sized papers. The method used was similar to that which was later presented as TAPPI method T 458. It was found that those papers that were white spotted produced a contact angle of over 30° with water. If the contact angle was lower than 30°, white spotting did not occur. It thus appeared that the regulation of the pH of the glue size produced more complete coverage of the cellulose fibers by the glue and also produced a surface condition on the paper that allowed better wettability without increasing penetration through the paper.

No comparable study had been made of the effect of surface size pH on envelope gum adhesion beyond the fact that two different papers were used for envelopes that had been sized at the mills with glue of widely different pH, namely about 5 and 8.5. Envelope blanks were cut from both of these papers and placed in a fast operating, plunger-type envelope machine where they were gummed with the same dextrin. The envelopes made from the paper at the higher pH were judged to have better adhesive properties than those made from the paper sized with the glue near the isoelectric point. This particular application of controlled pH of glue size to envelope paper had more theoretical than practical application. The reason for this is that starch technologists have improved both their products and salesmanship so that more bond and writing papers are now tub sized with starch than with glue. This trend was welcomed by both the paper manufacturer and the envelope converter. The former was relieved from the pressure of producing special papers for envelope converting and the converter had less trouble in making satisfactory envelopes.

This does not mean that the envelope manufacturer has no further problems. There is always the possibility of further improvements as well as the battle for uniformity of raw materials. As long as he uses natural products such as dextrins, he will be confronted with the necessity of overcoming variables created by either Mother Nature or the dextrin manufacturers. Whether the development and use of new resins would solve these difficulties or not is a moot question. The chemical industry has produced materials that give to the papermaker the equivalent of hydration or beaten fibers. It may also give synthetic gums to the envelope converter . . . why not?

CHAIRMAN: The next speaker is R. W. Reiter, a graduate of Wheaton College, who has been research chemist for the National Starch Products, Inc., since 1947 and has worked specifically in supervising the development of new resin research products.

Some Applications of Vinyl Acetate Polymers to Paper

R. W. REITER

THE increasingly specialized products of the paper manufacturer and converter have in the last few years led to greater interest in the addition of resins to paper. These products have enabled great advances to be made in the packaging industry. Special requirements of strength, flexibility, and chemical resistance are incorporated in many government specifications. Also there is a particularly widespread demand for grease-resistant papers. The decreasing availability of our stronger-fibered pulps has stimulated increased interest in additives promising stronger sheets. Stretching and curling of paper in the presence of moisture is a problem in lithographing, in the use of steam-set inks in printing, and in the labeling of cans and bottles. Manufacturing of higher opacity sheets requiring greater quantities of fillers depends upon being able to maintain sheet strength. Greater strength with less beating would be desirable from the standpoint of beater operation costs, compressibility, opacity, and other properties of the finished paper. Resins offer the possibility of solving these and other problems.

In discussing the use of vinyl acetate polymers consideration should be given to both the mechanical factors involved in the use of any resin and to the chemical properties inherent in polyvinyl acetate. The mechanical factors involve the method of addition of the resin to the paper and types of equipment on which it is to be applied.

Resins are currently applied in the paper industry by five, or perhaps more accurately, six different methods. Active work is under way in the application of vinyl acetate polymers to each of these fields. In one method the resin is added to the stock either in the beater or at some other point ahead of the wire. In beater addition the resin is added to the furnish in the beater and mixed with the stock for a definite length of time. In recent years a considerable interest has developed in increasing the dry strength of paper. This is particularly true in view of the fact that the longer fibered pulps are becoming scarcer. The always present problem in the mill of

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cutting down on the cost of making the sheet has always made the thought of reducing the beating time very attractive. If the beating time can be decreased, substantial power savings are possible. Without the addition of special additives, however, this results in lower burst, lower tensile, a lower fold, and a more porous open sheet. Polyvinyl acetate emulsions of fine particle size show promise as additives to improve dry strength. The main problem is to efficiently retain the polymer in the paper by precipitation with alum, for example, or by making the dispersion cationic and more substantive to the fiber itself.

The second type of addition is by size press or calender application. These two can properly be classified together even though they are applied at different points on the machine. A material for either application has to be thin and fluid. Tub and calender sizings are usually applied in order to give a certain degree of resistance to penetration of inks and to improve the density and finish of the sheet. Polyvinyl acetate emulsions impart improved stiffness, grease resistance, good color, and aging properties. One great problem has been the tendency for the polymer to transfer on the drying rolls or calender stacks due to its tackiness while wet or hot. Antiblocking agents such as casein, starch, CMC are, therefore a necessity in most cases.

Impregnation or saturation is a third method of applying resins to paper. In this method the wet web or the dry paper is run through a bath of resin. The resin is soaked up by the blotterlike action of the paper. A fairly open usually unsized sheet is used for this process. Some difficulty is often encountered in saturation due to the fact that the resin tends to deposit on the surface of the sheet rather than to saturate the whole sheet. Smaller particle size emulsions and wetting agents aid in this problem. Another problem has been the migration of plasticizer from the resin used. It is expected that polyvinyl acetate copolymers with "built-in" integral plasticization will be of interest here.

A fourth method is that of laminating paper to other polar sheetings such as saran, foil, cellulose acetate, fiber glass yarn, and cellophane. Solvent solutions and emulsions are most commonly used. They are coated on one of the sheetings by reverse roll, gravure roll or knife and either wet or heat and pressure combined after drying. Polyvinyl acetate materials are used because of their fast set, freedom from odor, nontoxicity, good color and greaseproofness. A number of barrier laminations under specifications Mil-B-130A, Jan-B-121, Jan-P-117, Jan-B-108, and Mil-C-1019B, are being made with polyvinyl acetate materials.

The fifth very important method is by coating. Under this we may include two types of coating. One is the commonly known clay coating with such binders as starch or casein, or starch-latex combinations. The second type may be considered as entirely a resin coating. This may be done with hot melts, solvent solutions, or emulsions. Most latices of the synthetic rubber type are very thin fluid materials not suitable for this type of application because of their penetration into the sheet. However, by formulating with suitable thickening agents this effect can be minimized. Polyvinyl acetate emulsions have a natural viscosity in the correct range for coating, particularly by roller or knife coating. Perhaps the most rapidly growing use for these coatings is in the greaseproof field. More will be said about this later.

Now that a number of methods of applying resins to paper have been outlined, and related to current problems with vinyl acetate polymers, the properties of these vinyl acetate polymers will be discussed.

Polyvinyl acetate polymers are well known as adhesives for polar materials, such as glass, paper, and foil. The unmodified straight polymer is film forming at room temperature and is heat and light stable. The polymer is supplied commercially in many forms, namely: emulsion, solvent solution, hot melt, dry, and alkali soluble. Each of these physical forms has some advantages of application.

The dry or lump resin is relatively the most stable in storage and offers the possibility of making solvent solutions in any desired practical solvent. A major disadvantage is the need for heavy mixing equipment or heat for hot melt application.

Hot melts offer maximum speed of set as there is no solvent or water to be driven off. They are perhaps the most difficult to apply, however, in economically thin continuous coatings because of their high viscosity. That this can be done is evident though from the application at high machine speeds of hot melts for bookbinding. These polyvinyl acetate copolymers are generally compounded with plasticizers and extending resins. They are almost entirely free from fire hazard and do not require exhaust, drying, or solvent recovery equipment.

Solvent solutions are especially good for laminating paper to cellulose acetate, for example, and for applications where impregnation is required. While precautions must be taken to prevent fires, their fast drying rate is an advantage over the water-soluble or dispersed resins.

Emulsions of these polymers offer the most versatile means of applying films or impregnating paper. They are the most adaptable because they can be thinned with water and machine very well under the most difficult conditions. No solvent recovery, heat regulation, expensive mixing equipment, or fire precautions are necessary. Drying equipment admittedly must be properly located and very efficient in order to allow high machine speeds.

Emulsions of polyvinyl acetate polymers are unique in one other respect, that is, they can be compounded with a host of modifying ingredients such as plasticizers, solvents (even water-miscible ones), resins and wax dispersions which are not necessarily compatible in the true sense with the polymer. A review of these ingredients and how they are added will serve to point out how the basic polymer properties can be modified.

Emulsion formulating or compounding techniques are often simple but always demand a knowledge of the base resins, dispersing systems, and nature of each additive. Plasticizers can be added directly without previous emulsification—solid types such as orthonitro biphenyl can be melted and added in the same manner. If nontoxicity is to be retained in the system, a number of plasticizers are available which are efficient, nontoxic agents for making the polymer soft and flexible. Upon the addition of plasticizer some thickening occurs, and the emulsion performs as a higher solids dispersion which it truly is.

Solvents act in many ways like plasticizers except that they may be driven off during drying. They generally aid in drying rate, film forming, and water resistance. Certain emulsion systems allow the addition of water-miscible solvents which would normally destroy the delicate balance of a normal emulsion system.

Water-soluble colloids such as starch, carboxy methyl cellulose, alginates, and polyvinyl alcohol are of great importance as viscosity controlling agents and as additives to minimize penetration of the resin particles into porous stocks. This is especially necessary where particle sizes are small.

Resins such as the rosin derivatives, urea-formaldehydes, cumars, and waxes are used as extenders and modifiers. It is necessary in some cases to raise the pH of the polyvinyl acetate emulsions in order to obtain compatibility. Additives such as these generally improved block resistance.

Pigmented and dyed emulsions are also possible. Pigments may be ground separately or in the presence of the emulsion. Very good binding and excellent color are obtained by this combination.

With this review of compounding it is in order also to point out that further versatility is obtained by copolymerization. Depending upon the nature of the second monomer, this can result in improved: (1) film formability which enhances film continuity and gloss, (2) permanent flexibility and soft-

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ness which is nonmigratory, (3) adhesion which gives superior bonding characteristics, and (4) chemical resistance to moisture, solvents and greases.

A few examples illustrate these variations:

PVAc polymer	Sward Hardness Emul.	Soln.	Min. block, °F.	Alkali sol., %	Glass adhesion
Straight	38	44	110	20	Good
Carboxyl	38	48	130	75	Excellent
Internally plast.	24	14	100	15	Good
High int. plast.	4	2	65	15	Good
Conditions	72°F.		Face to face 1 p.s.i.	1% NaOH 1/2 hr. 85–90°C.	

An interesting variation is that of integrally plasticizing the polyvinyl acetate where the flexibilizing agent is a monomer itself and is permanently locked into the molecule. Its permanence is demonstrated by a simple experiment where films were cast on glass fully dried and then heated at 130°C.

	Sward rocker hardness		
Hours at 130°C.	Polyvinyl acetate	PVAc with 30% dibutyl phthalate	Integrally plast. PVAc
0.5	48	14	14
1.0	40	28	16
1.5	44	36	16
16.0	40	40	16

It is obvious that the plasticizer is volatilizing. This same effect is noted when the films are in contact with sheetings into which the plasticizer can migrate.

A practical application of this integral plasticization has been in the greaseproof coating of paper where emulsions have the advantage of operating at a uniform viscosity. Compared to the other forms, emulsions are also more economical, easier to clean from machinery, and cause no fire hazard. Greater resistance to blocking is usually an advantage as well. It may be of interest at this point to list some of the factors affecting these coatings and the continuity of film and hence their efficiency in greaseproofing:

1. Paper or board—sized stocks of paper because of their lower absorbency aid greatly in uniform coating, freedom from pinholing, and economy of this operation.

2. Coating viscosity—each type of material and method of coating and indeed, each manufacturer's conditions of application has an optimum coating viscosity. Suitable viscosities have been found to be of the order of 500 to 1000 cp. for reverse roll; 100 to 200 cp. for air knife; and variable from very high to very low for knife coating.

3. Drying—water must be driven off to minimize tackiness. Some polyvinyl acetate emulsions (which are comparatively soft as compared to other high polymers) do not cause trouble if fully dried. As this is probably the knottiest problem to solve, it may be important to point out that work in our laboratory shows that this problem can be overcome by the use of highly efficient driers such as the radiant glass-type units.

4. Solids content—higher solids contents improved drying rate and uniformity of film.

5. Flexibility—this may be a necessity for end uses in unit packaging to prevent cracking during the carton forming operation. It can be accomplished by post plasticizing or by integrally plasticizing. In this latter case the coating will remain flexible even after extreme accelerated aging tests.

These greaseproof coated stocks find application in packaging bakery goods, machine parts, meat, oleo and the like. They are also of interest in making paper plates, cups, and self heat sealing coatings.

	Grease resistance, min.		
PVAc polymer	Flat	Fold	7 days at 160°F. fold
Straight	30	0	....
Straight +5% plasticizer	30	30	0
Straight +10% plasticizer	60	30	Spotty
Integrally plast.	300	300	300

[a] Coating weight was 20 lb/ream (3000 sq. ft.) on board.

In conclusion, it has been pointed out that polyvinyl acetate polymers are extremely versatile materials and have properties that make them of interest to paper manufacturers and converters. A review of the methods of application of resins in general has been made, and some information on compounding and copolymers has been given for polyvinyl acetate emulsions. The application of these polymers for greaseproofing is perhaps of greatest interest at this time.

The author is indebted to Mr. Gold of our Resin Development Department and Mr. King of our Paper Department for some of the information in this paper.

CHAIRMAN: The next paper is quite complimentary to the first and will be given by Bob Vokes, who incidentally is a graduate of the College of Forestry here and has been in the pulp and paper laboratories at Dilts Machine Works as Chemist and later as Director of their laboratories. Since 1948 he has been Assistant General Manager at the Dilts Machine Works, and was promoted to Gen. Mgr. in February, 1953.

Methods of Reverse Roll Coating

R. F. VOKES

THE architects of this National TAPPI Paper-Plastics Conference have prudently recognized a most significant element affecting the forward progress of the paper-plastics industry. For without the tools to produce new products made possible by the wedding of the separate paper and plastics industries, the offspring of the prolific research laboratory experiments may never see the light of day as commercial commodities.

Methods of applying plastics to paper must be developed to keep pace with the rapid growth of the plastics industry. To be sure, some of the prior art and methods employed in the paper coating and impregnating operations will be of service, particularly as a starting point. Beyond this, however, the combined talents of the plastics chemist and the paper technologists must look for new methods to produce the new products. The burden of development of new methods properly rests with the builders of machinery and related equipment required for complete systems to be integrated in such a manner that all elements are made to function as a whole. The complete cooperation of the paper-plastics converter, however, facilitates the solution of such equipment development problems.

Development responsibility vested with and assumed by the machinery builder requires that proper tools be made available for the purpose. While a "test tube" may be sufficient for the chemist, the machinery builder must have a combination of engineering talent and pilot plant equipment to learn how to put the chemical products to use in a practical manner. Customers for new chemical products from the plastics industry and customers for new equipment and methods for applying said products to paper and fabric webs are entitled to be provided with concrete evidence, preferably on a commercial equivalent pilot plant scale, that both the chemical product and the method of application are feasible. Too much emphasis on the commercial scale equivalent pilot plant operations as to roll sizes, speed, adequate width for actual

R. F. VOKES, Dilts Machine Works Div., The Black-Clawson Co., Fulton, N. Y.

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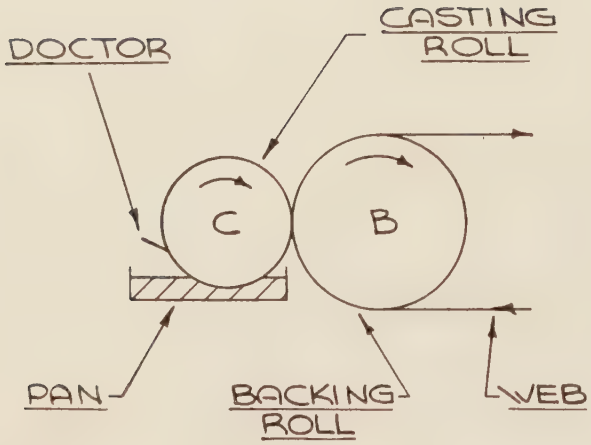


Fig. 1. Reverse roll coating method

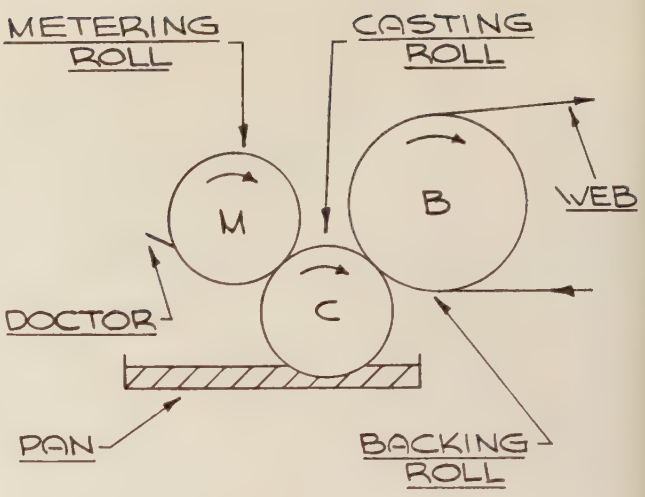


Fig. 3. Reverse roll coating method

product sales, and use of commercial operating techniques and controls cannot be made. An interesting future reference on this subject is indicated herein (*1*).

To meet this challenge, the Dilts Machine Works, Division of The Black-Clawson Co. operates at Fulton, N. Y., a complete coating installation for handling coatings including those with highly volatile solvents. The coating line includes an unwinder equipped with a running belt constant tension control, four-roll reverse roll coater, drying tunnel, cooling drums, and constant tension center winder separately driven by variable speed electric motors. The principal feature of this installation, however, resides in the coater which constitutes the major developments of a coating method geared to the needs of the paper-plastics industry. The following analysis is based primarily on the pilot plant experiences.

REVERSE ROLL COATERS

Reverse roll coaters are generally recognized as the proper equipment for precision coating at a wide range of viscosities on webs of irregular surface characteristics. These coaters have the inherent feature of metering the coating accurately before being deposited on the web, plus the feature of increasing the coating film thickness without loss of accuracy and control at the point of application. The literature (*2–6*) on coating equipment reveals the existence of four types of reverse roll coaters. These are shown diagrammatically in Figs. 1 through 4. Roll B in each case is a backing roll which has a resilient rubber-covered surface; roll C is the casting roll which is a precision ground metal roll for applying the metered coating to the paper; roll M is a metal metering roll for controlling the amount of coating by reverse wiping of the casting roll surface by a closely controlled aperture, and roll D is a metal dip roll employed for applying the coating to the casting roll ahead of the metering roll on the four-roll coater. Roll doctors are employed as shown for cleaning the metering roll. Roll rotation is indicated on the diagrams. This type of coater is therefore well adapted for the paper-plastics industry applications and useful for the uniform application of specific film thicknesses of plastisols, organisols, vinyls, lacquers, shellac, latices, emulsions, and other solvent-type coatings.

THREE-ROLL REVERSE ROLL COATER

The three-roll coater shown in Fig. 3 employs a coating fountain which is made up of a back dam and two side dams to hold the coating in the nip of rolls C and M. Hence the dams must ride the roll surfaces if edge control of the coating application is required to vary the width of the web of paper being coated. Side dams of the coating fountain may also be placed at the ends of the rolls, hugging the roll end surfaces,

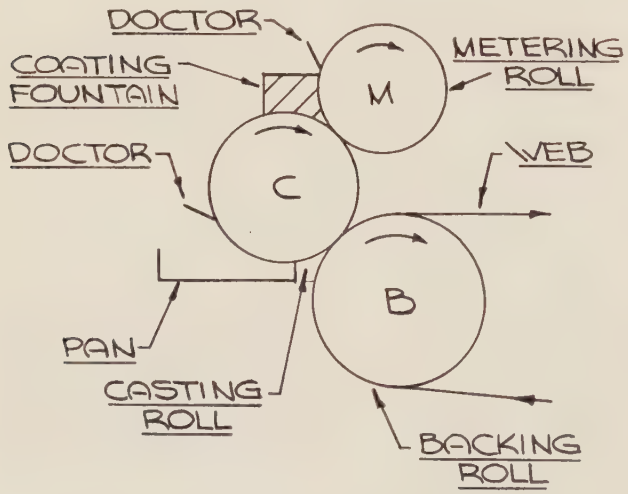


Fig. 2. Reverse roll coating method

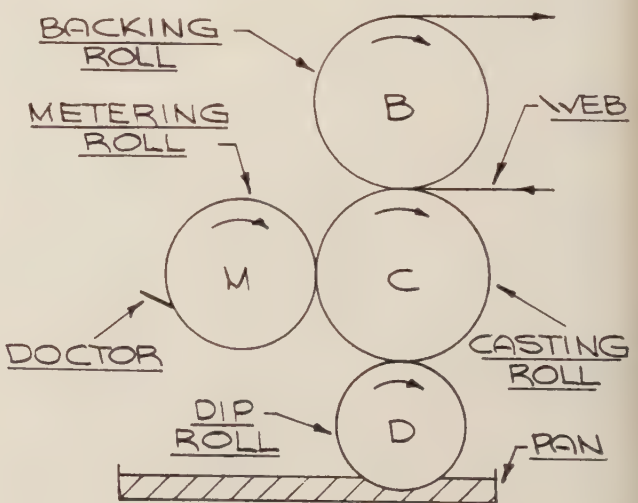
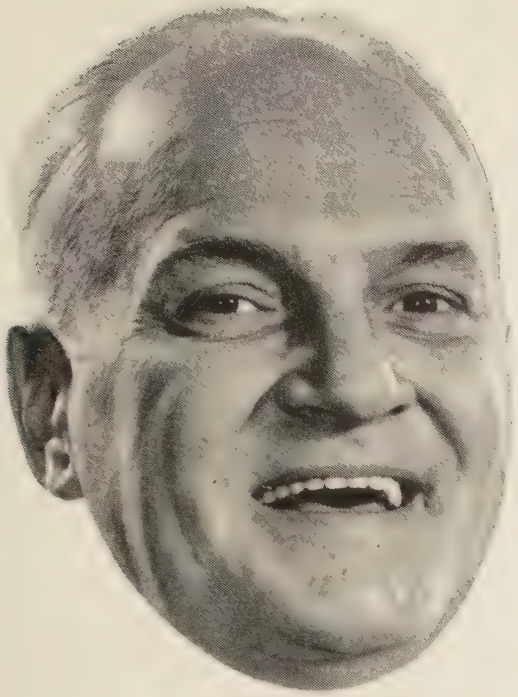


Fig. 4. Reverse roll coating method



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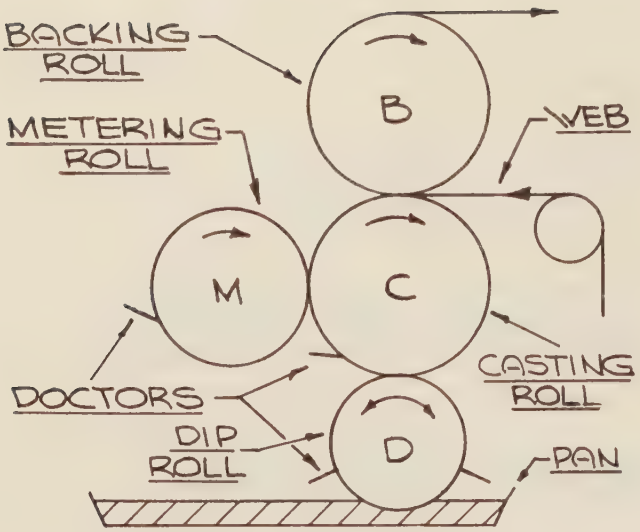

Fig. 5. "Contracoater" Reverse Roll Coater

thus permitting the application of coating across the entire width of the roll surfaces. Unfortunately, with this design, the coating can get between the side dams and the finely ground roll surfaces, and either mark the rolls or contaminate the coating (*7*). Also, it is noted that an adjustment of the metering roll position to vary the amount of coating applied requires a corresponding adjustment of the dams. This results in the possibility of leakage of coating past the dams and resulting contamination of the casting and backing rolls. Such leakage, roll marking, and contamination are detrimental to the flexibility of operation on varying widths of webs and, of course, the quality and uniformity of coatings applied.

FOUR-ROLL REVERSE ROLL COATER

Coating literature survey covering equipment references has not revealed a record of experience with the four-roll type of coater shown in Fig. 4. The diagram shown has been reported (*6*) but without support in description or comment. Essentially, the principles covering the actual deposition of the coatings on to the paper webs by reverse roll pickup are identical in all cases. The significant elements of difference, which are of interest to the purchaser and operator of such equipment, however, constitute the major contribution to the development of reverse roll coaters for the paper-plastics industry.

"CONTRACOATER" REVERSE ROLL COATER

Figure 5 depicts the four-roll reverse roll coater identified as the "Contracoater." Note that this design is modified from that shown in Fig. 4 by the rotation of roll D and the inclusion of edge doctors on the casting roll C. Actually, the dip roll D is arranged for rotation in either direction as desired.

The operation is simply described by noting that roll D picks up a relatively heavy film and forms a puddle at the nip with roll C. The nip is adjusted to the desired clearance so that a proper film of coating is carried up to the nip formed between rolls C and M. The edge doctors remove the coating from the casting roll and/or dip roll surfaces from the ends toward the center and according to an adjustment which is determined by the width of the paper being coated. Accuracy of coating film width is maintained to conform with the paper width within $^1/_8$ in. of the edge, thereby reducing edge trimming of the coated sheet to a minimum.

At the nip formed by rolls C and M the precise metering of the coating film is determined. Precision grinding of the rolls to 0.0001-in. tolerance, precision bearings and precision adjustment of the clearance are of primary importance. The differential speed is adjustable and generally roll M rotates at a speed range of one third to one tenth of roll C.

The coating film metered as to thickness and width is carried to the nip between rolls C and B. The paper passing in the direction of roll B wipes the coating from roll C and the precise thickness of the resulting coating film on the paper is further determined by the speed ratio between rolls C and B. This ratio is infinitely adjustable from 1:1 up to 5:1, depending upon the coating thickness involved, thus providing an increase in film thickness deposited on the paper web as desired. Some quantitative data on this subject of control have been published (*6*).

Credit for the development of the "Contracoater" rests with John S. Friedolph who initiated the experimental development work on a three-roll machine converted to a four-roll machine. He confirmed his theories in production and held the belief that this design would fulfill a great need in the paper-plastics converting field. His reasoning is clearly established in the following tabulation of comparative features of the two types of reverse roll coaters.

Reverse Roll Coater Comparison Chart

		Four-roll "Contracoater"	*Three-roll type*
	Visibility by Operator		
1.	Coating and the alignment on casting roll	Good	Poor
2.	Paper being coated	Good	Poor
3.	Down coated sheet	Good	Fair
	Coating Control		
1.	Foreign particle protection against streaking and damage	Good	Poor
2.	Gravity effect	None	Some
3.	Metering nip controls	Two	One
4.	Volatilization loss control	Fair	Good
	Variable Width Operation		
1.	Edge control of coating	Good	Good
2.	Flexibility for change	Good	Good
3.	Scoring of rolls by dams or doctors	Seldom	Often
4.	Coating contamination and creeping at dams or doctors	Seldom	Often
	General		
1.	Cleanup and servicing for order changes	Good	Fair

TEXTILE INDUSTRY

This industry has developed a vital interest in the methods and equipment employed in the paper converting industry, particularly with regard to the application of plastics. Developments in plastic coated fabrics are well known to those who outfit their homes and offices with modern furniture and draperies, not to mention wearing apparel.

The reverse roll coating method therefore has an important place in the textile field since the uniformity of coating on an irregular surface is made possible. Also it is shown that both an extremely thin coating film and a very thick plastic covering can be applied on the same reverse roll-type machine. The choice of equipment, however, still involves careful consideration of the above comparative factors and, of course, the textile manufacture cannot afford to pass up an opportunity to obtain commercial equivalent experimental pilot plant evidence that the equipment will perform the required functions to yield his product at a competitive advantage.

DECISION

Day-by-day decisions on methods of coating must be made by members of the paper-plastics and textile-plastics industries. Reverse roll methods have been recognized as most universally applicable in the fields under consideration.

Emphasis on the three-roll and four-roll types of reverse

A Progress Report on the Status of FluoSolids

Applications of Non-Catalytic Fluid Techniques Expanding into Many New Fields

Pioneered by Standard Oil Development Company during World War II, fluidization is today widely recognized as an ideal means of promoting intimate contact between solids and gases. As licensee in all non-catalytic non-hydrocarbon fields, The Dorr Company has continually expanded the applications of this new technique since 1944. At the present time, FluoSolids is demonstrating outstanding advantages in the processing of a wide variety of metallic and non-metallic minerals, and holds great promise for the future in other fields not yet fully developed.

GOLD

One of the first applications of the Dorrco FluoSolids System was the roasting of arsenopyrite gold ores prior to cyanidation, and several installations have been operating with marked success for two to five years. Latest development for gold roasting is the split compartment Reactor. In this type of unit, preliminary reducing conditions are provided in one half of the Reactor and a complete oxidizing roast in the other, resulting in decreased cyanide consumption and better metallurgy at the mill.

PYRITE

The sulfur shortage has contributed to great activity in the pulp and paper field. Eight FluoSolids Systems in the U. S., Canada and Norway are either in operation or under construction in sulfite pulp mills, for the production of SO_2 for cooking liquor. Eight more are in operation or being installed to produce SO_2 from pyrite, pyrrhotite and low grade sulfur ores at acid plants, which will produce over 1200 tons per day of H_2SO_4 by the contact method. This impressive record results directly from the fact that FluoSolids can deliver a high strength SO_2 gas at lower investment and operating costs than conventional roasters and provides users with an economically feasible and reliable source of SO_2 despite fluctuations in natural sulfur supply.

ZINC

The first commercial FluoSolids installation for the roasting of zinc concentrate went into operation in the summer of 1952. It is producing SO_2 gas for sulfuric acid manufacture and a desulfurized zinc calcine for leaching, prior to electrolytic zinc production. Results to date have demonstrated marked simplicity of control and operation, and two other zinc producers have ordered similar Systems.

COPPER

More recently, the first FluoSolids System to provide a sulfating roast to a copper-zinc concentrate went into operation. In this application, close operating controls make it possible to render the valuable base metals soluble and, at the same time, minimize solubility of the iron. This permits high recoveries of copper and zinc by leaching. When followed by electrolytic precipitation, economic advantages are indicated under many conditions as compared with conventional smelting practice.

NEW DEVELOPMENTS

Studies to explore the utilization of FluoSolids for the beneficiation of low grade iron ore are now being conducted. In this operation, hematite is given a reducing roast to convert it to magnetite for subsequent concentration by wet magnetic means. Higher unit recovery of iron and the production of better concentrate grades indicates improved economics as compared with other beneficiation methods.

Among the other numerous fields currently under investigation are the calcination of alumina, the reburning of precipitated lime sludge and the self roasting of low grade sulfur ores.

If you would like more information on FluoSolids — the most significant advance in roasting technique in the last 30 years — write The Dorr Company, Stamford, Conn. or in Canada, The Dorr Company, 26 St. Clair Avenue East, Toronto 5.

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roll coating methods is made herein because control of plastic coatings to minimal amounts for each application is paramount. Too much coating film at present-day costs cannot meet competition price-wise. Too little may not give coverage and the paper-plastics converter cannot send the broke back to the beater room.

Decisions as to type of reverse roll coater and complete systems including drying ovens, unwinders, continuous or discontinuous operation, cooling methods, winders, etc., must be made by both the machine builder and the operator. The tools required for working out the solution to proper decision on methods and equipment should be jointly provided. The paper-plastics chemist should provide the raw materials and present the problems. The machine builder should provide the commercial equivalent pilot plant tools and trained engineers to help remove the guesswork from the path which leads to the correct decisions.

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Panel Discussion—Problems in Applications of Resins to Paper

CHAIRMAN: The subject this afternoon again I am hoping will stress the problems in application of plastics to paper. I would like to ask each of these men to say a few words about some specific problem they know of in the field of plastics application to paper hoping it will stimulate some discussion on your part as well as the members up here. I will call on Mr. Pullman to say a few words to us now on problems.

JOSEPH PULLMAN (American Cyanamid Co.): I don't know whether this is a problem but I would like to touch on getting the maximum physical and chemical properties in resinous materials when used in mechanical application. This is becoming more important as time goes on.

Now, all these methods of application have been very ably described by our speakers this morning. There is one thing I would like to do here, in just a few minutes, and that is to cite a few examples that I know of where the properties of the resins were used in developing a method of application.

One such technique is the beater addition of resins to pulp stock. Some of you here know that the American Cyanamid Co. has developed a process for doing this which is known as the Bardak method. This was the outgrowth of their work in the field of wet-strength resins, particularly those of the cationic type. It was found that if the negatively charged pulp were treated with cationic phenol resins—we could use melamine or urea resins for this purpose as long as they were cationic in character—and when they were added to the pulp stock, it apparently changed the charge of the lignin. The negatively charged cellulose became a positively charged fiber and this amino resin charged fiber, subsequently brought in contact with the cationic resin dispersion, the anionic resin selectively absorbed on the surface of the fiber and precipitation occurred at the fiber interface. Properly conducted, very little resin would be lost.

Now, this technique worked very well with quite a number of anionic resin dispersions but there were some that did not work too well. That is, they worked very well as far as the basic principal was concerned but with some latices, such as GRS and many rubbers, the resin-treated stock had a tendency to ball up and resulted in either poor sheet formation or it was almost impossible to run a sheet at all.

In order to overcome this, a solution was found in the modification of the resin in the rubber latices prior to the stock addition. This modifying agent is added to the resin dispersion prior to stock addition—roughly in a neighborhood of 5 to 10% and a small amount of alum is also added along with the modifying agent.

Now, this modified resin dispersion is then added to the amino resin treated stock. The precipitation of fibers is as before but there is no clogging so it is now possible to utilize the Bardak process for incorporating a much wider range of resins and synthetic rubber latices in stock additions.

I might also say that this modified resin dispersion is very stable to alum and no precipitation occurs regardless of additional quantities of alum.

Now, in general, this Bardak process with the modifications to prevent fiber clogging is capable of being used for the addition of both small and large quantities of resin to paper stock prior to sheet formation.

Another example of the properties of resin being taken particularly into account is the application of paper with polyester resins.

We have had an excellent paper on the subject of polyester and I am not going to say anything about the chemistry of resins other than to indicate possible means of application to paper.

One that has been discussed is the continuous lamination of paper. Those who were here yesterday may remember that several pieces of paper individually treated with the polyester resin were combined and carried through the drying chamber between two sheets of cellophane held on a frame but, nevertheless, a continuous operation was possible.

The other possibility in the application of polyester resins to paper—bearing in mind that the polyesters are thermosetting resins and the curing time, pot life, etc., are quite important—is the possibility of running continuously utilizing a method developed in the plastics industry—that is, the double nozzle spray. You have heard Mr. Dean mention yesterday how rapidly a polyester resin can be gelled by the use of certain accelerators as well as the peroxide-type catalyst.

This method which has been developed consists of two nozzles spraying simultaneously—the resin sprayed from one nozzle contains the catalyst; and the same resin sprayed from the other nozzle contains the accelerator. Were the two to be mixed, the pot life would be so short as to be impractical, but held separately in this manner, the pot life is very practical for working time. The two nozzles are so arranged that the spray pinches on the same point at the same time and the particles of the two resin solutions—using the material solutions I have referred to with the catalyst in one dispersion and the accelerator in the other—when these two sprays meet on the impinged surface, they coalesce bringing all the desirable components of the polyester resins together at the same time and the gell action occurs very rapidly. By selecting your catalyst and accelerators, it is even possible to cure the resin at room temperature, perhaps in a period of about 3 min. travel time. This will probably be greatly speeded up by the addition of some heat. I can readily see that this type of application will lend itself rather well to pulp articles, etc., and it also points the way to possible continuous web coating. There again we have an example of where the physical and chemical properties of the resin involved can be used to advantage.

Finally, I'd like to cite an experimental problem which occurred in the application of a surface coating of a resinous material which was crystalline in nature. When this resin—this crystalline solid was melted to a totally liquid form, it will crystallize rather slowly on returning to room temperature. On the other hand, the heat stability of this product was very good so it lent itself to hot-melt applications more than any other method. But, due to the nature of the product—due to its slow return to a crystallized state and re-

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The contract was let by Bowaters' representatives in the office of J. E. Sirrine Co., consulting engineers to Bowaters Southern Paper Corporation. The Sirrine firm was also engineers for the Coosa River co-operative newsprint mill in Alabama which is now in production.

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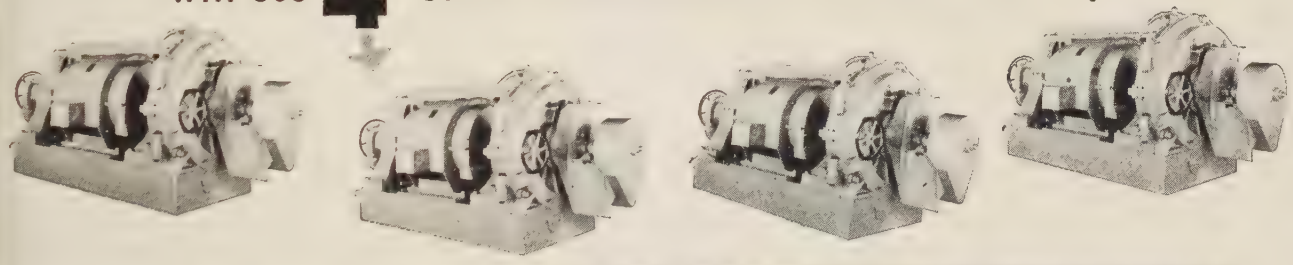

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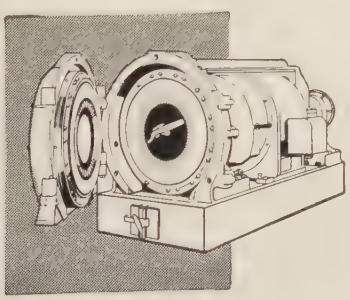

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sulting contact on the surface—it would obviously mean a long time would have to be permitted to elapse before rewinding or else very slow winding operation would be needed.

One thing used to get around this was the fact that the resin was soluble and, therefore, by spraying the tacky surface of the coated sheet immediately after the coating, it was possible to obtain a partial solution and then the evaporation of the solvent used caused a crystallization of the solution thus seeding the remaining layer of resin and inducing the proper crystallization in the entire mass.

Now these are only a few examples of where the physical and chemical properties of these several materials have been used in working out possible techniques of applications to paper. I think this established trend will continue to grow and in the future we may expect to witness the use of resins which are considered most impractical by the paper industry today.

Question: I'd like to ask the speaker what steps can be taken to overcome the inhibiting action of air in the curing of polyester resins?

Mr. Pullman: I'd answer that by saying it can be done by the proper formulation of the resin used; in the selection of the resin and the catalyst and the inhibitor. In other words, it is possible to make such a combination. This double nozzle spray is currently being used by the plastics industry.

Question: Is this crystalline resin emulsified?

Mr. Pullman: Only with the greatest of difficulty. It is possible to make a water dispersion but most of those I have seen were pasty in nature.

Question: What about the importance of pH?

Mr. Pullman: I didn't find the pH was too important if the amino resin is added to the stock under proper conditions. There are no subsequent additions but an adjustment of the pH may be necessary. There has been a lot learned since the process was first developed and I think one of the things in that connection was the finding that a wide range of pH was possible.

CHAIRMAN: Next we will hear from Paul Yoder.

PAUL YODER (Pyroxylin Products, Inc.): This covers a few remarks about the problems with hot melts, two problems specifically—there are several others we won't go into.

One thing we run into frequently in the application of hot-melt coatings is the lack of proper temperature controls, or the lack of uniformity in the temperature throughout the coating equipment. Any remarks that are made here are not slurs or criticism being made on the machinery manufacturers.

The requirements will differ with the particular application. However, one of the chief difficulties is this: if a hot-melt coating machine is heated by direct electricity—the pan, the roll, the smoothing roll or smoothing bar—it is extremely difficult to maintain a uniform temperature through a roll or across a smoothing bar. Consequently, the viscosity of the coating itself will vary either from one point in the web to another—or even across the web, which means that the coating weight cannot be properly applied uniformly across the web.

Some means of heating, such as steam or circulating hot oil, will certainly help to eliminate these difficulties and localized overheating, particularly in certain types of hot melts. Overheating is something that is very deleterious to the hot melt in spite of the fact that the manufacturers of hot-melt materials have tried to overcome the problems.

The other problem which frequently causes trouble both to the operator of the machine and the manufacturer of the coating material is that of tension. The tension in the web may vary from one point in the web to another, or more frequently vary across the web. The wider the web, the more tension variation there will be. Certain mills pride themselves on producing rolls which are not baggy but nonetheless you still come up with baggy rolls. Where a coating is being applied—where it is being metered before application to the sheet—tension control is no great problem. However, there are certain types of equipment that apply an excess of coating to the paper and the web is then doctored by either a knife or wire-wound rod or some such mechanism as that and if the tension on one side of the web varies from the other, you will apply a heavier weight of coating on the baggy side and a lighter weight on the tight side.

There are ways of overcoming this but, nonetheless, it is still a problem which is one I think all people who use that type of equipment have to face.

Chairman: There are several questions here directed to Mr. Vokes which we might take up. The first one: Please compare gravure and reverse roll coating methods for application of lightweight solvent solution coatings to heavy paper base stock.

Mr. Vokes: I think perhaps I can answer that in part on the basis of what my limited experience has been. To begin with, from the standpoint of use of gravure coaters compared to reverse roll coaters, I believe that you should keep in mind for extreme accuracy in application of the coatings, in film thicknesses less that one mil, that perhaps your best bet is the gravure type of application. Thin coatings applied to either thin paper stock or thick paper stock make little difference. Paul Yoder has pointed out in attempting to apply extremely thin coating that with a gravure you do run into the problem of more direct pinholes. That can tend to be overcome by the proper operation of the reverse roll coater.

Chairman: Here is another question that I think is directed to you. How thin a coating of a vinyl plastisol at 60,000 cp. viscosity could you apply with the Dilts Contracoater?

Mr. Paxton: We have never run 60,000 cp. plastisol yet. That would be very difficult.

Chairman: This is the second part of that question and apparently the questioner realized you might not be able to answer the first part so he came back and said: What is the maximum coating viscosity that can be adequately handled?

Mr. Paxton: We have run rubber cement at 75 cp. but plastisols in the range of 25 to 35.

Mr. Clark: I might comment, in the case of the plastisol, one reason why the 35,000 cp. limit you mention might be true is that viscosity is measured at low shear rates and when applying off the reverse roll coater you are under shearing.

Chairman: Here is a question directed to Mr. Egan. What type coating head will produce the most uniform, pinhole-free, low coating weight film from a solvent solution on relatively heavy, rough surface, dry finished kraft base stock?

Mr. Egan: I think this was partially answered before. It would depend on thickness. Probably 1 mil wet coating would be the reverse roll coater, but then you are almost forced into offset gravure. But that "pinhole free" is a problem in direct gravure. If it is hot melt, you can apply heat and dry to smooth it out. If the temperature is not too high, you can go to indirect gravure with a rubber-covered roll that will stand the heat. I would say direct gravure for very thin coatings. Actually both of them under almost perfect conditions will still tend to give occasional pinholes. If you have to have it pinhole free, you have to make two passes.

I might add on the reverse roll coater, the 1 mil is a wet film with a solvent solution and you reduce the solvent to get down to a very low dry film.

Chairman: Here is another machine question. In the use of extrusion equipment, how do you minimize decomposition of residues when using vinyl chloride or vinylidene chloride resins?

Mr. Vokes: There hasn't been a solution to it for wide films but up to 36 in. you could use the method I showed in my paper. The point of entry from the extruder to the die is tapered so the volume in the die becomes less and in this application you have to have an extruder with sufficient capacity so the length of time the thing is in the die is less than the composition film—you have to keep it quite rapid. You have to—if you are using a capacity of 250 lb. per hr.; the coating may be half or two thirds the width of the die all right and beyond that you might get decomposition. The other thing is the heat stability of vinyl resins depends on the compounding of it. If you are talking about vinyl with a stabilizer the conditions I mentioned are more important than if you have a heat stable resin plasticized of an elastomeric type.

Question: I am not familiar with this indirect type but would that be similar to a transfer roll—would it compare to the impression roll for hardness of rubber?

Mr. Egan: It is the same roll.

CHAIRMAN: Norman Greenman came in a little late so I'd like to ask him to tell us a little about some of the work they are doing on beater additions.

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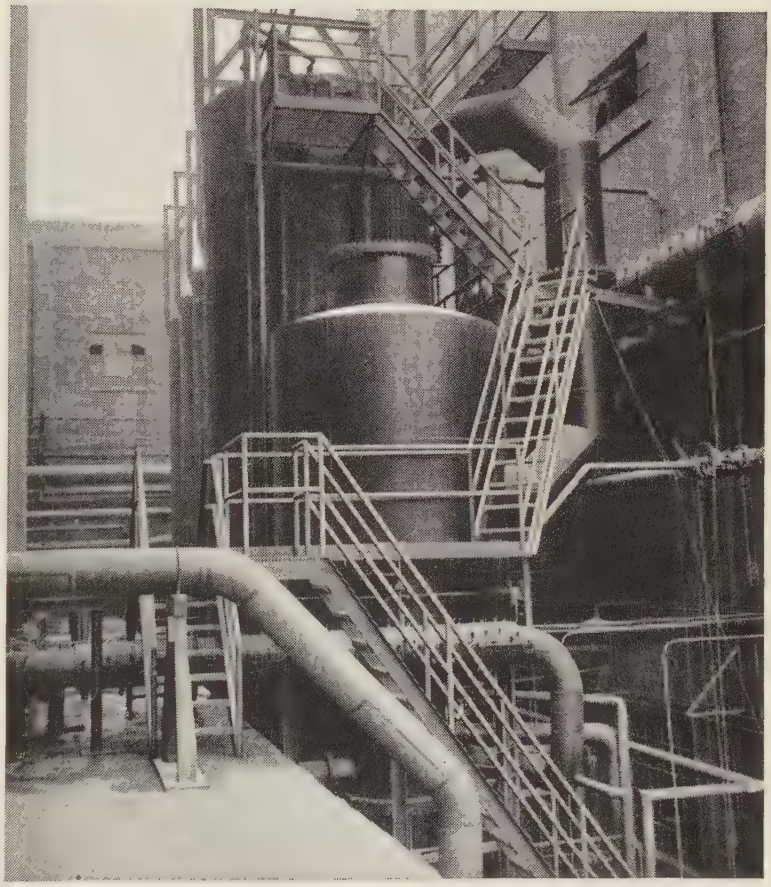

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there has been a tremendous increase in the amount of work and literature in the field of beater addition of resin to fiber. In recognition of that interest, the Paper Converting Subcommittee of the Plastics Committee of TAPPI has taken within its jurisdiction beater additions of resins or chemicals to fibers.

The subcommittee has defined the beater addition process as that process by which resins or chemicals are added to fibers before the papermaking web is formed. By definition, the subcommittee has excluded the standard urea and melamine wet-strength resins from being classified as beater addition products.

There is no question in anyone's mind that for some applications saturation and coating techniques are technically better than beater additions. It is our belief, however, that the beater addition field has been neglected and, in some areas, it can be superior to the older methods.

Mr. Nazarro has asked me, representing a company using the beater addition process to illustrate for you a product which we are making—a representative beater addition product, which we are producing and marketing at the present time.

You are all no doubt familiar with vulcanized fiber. For many years the zinc chloride process has been used to produce something useful in the electrical and mechanical fields in industry. The beater addition product I would refer to is a combination of phenolic resin and cellulose fiber. It is a hard, dense, fiberboard having similar properties of good water resistance, high mechanical and electrical properties, and the ability to be formed or shaped in fabricating operations. This material we call Duroid 700 and it has been listed by Underwriters' Laboratories as the equivalent to vulcanized fibers for use in electrical applications. As far as we know it is the only material to be so listed by Underwriters' Laboratories.

The process by which Duroid 700 is made is actually quite straightforward. An emulsion of phenolic resin is added to the fibers in the beater. The resin is precipitated on the fiber by a settling agent and the stock can be pumped over in the normal manner.

Actually the technique of adding resin to fiber has been well illustrated at previous TAPPI talks.

Naturally, the water resistance of this product depends on the amount of phenolic resin added to the beater. The physical characteristics depend to as great an extent on the type of fiber that is used. We have found that unbleached kraft and rag fibers give the best results: unbleached kraft for high tensile strength and rigidity when required and rag where more flexibility is desired.

Duroid 700 is one of several products being manufactured by this beater addition process. We hope to compete with the older processes of impregnation and coating.

It is my opinion the field has merely been scratched and the future of the beater addition process is great. We have seen only the beginning of a long and steady growth.

Question: I'd like to ask Mr. Reiter a question. Most of the polyvinyl acetate emulsions I have seen were quite viscous—certainly not suitable for saturation work. Has there been any effort or is there a product available which has solvents with low enough viscosity so they are suitable for saturation work?

Mr. Reiter: As far as I know there is nothing with a viscosity around 100 cp. if that is what you are talking about. There are some modifications which show interest along this line. Only a limited amount of work has been done because of the recent availability of this material. I don't think it is an impossibility. I think it will be a specially designed polyvinyl acetate and I think it will be worth while for this use. It will be designed to do this and nothing else. It is a necessity in uses where they are now applied.

Question: What is the fundamental reason why these emulsions have always been so viscous, whereas other emulsions can be made with 30% instead of your 50%?

Mr. Reiter: I think that is because they are not soap emulsified. They are generally stabilized by protective coatings which in themselves have quite a viscosity.

Question: Would it be possible to have them emulsified with soap?

Mr. Reiter: It is well known that that would be quite difficult The monomers lend themselves better to the soap system than the polyvinyl acetate.

Question: The polymer can be dissolved in a solvent and the solution emulsified but I don't know whether that would be difficult.

Mr. Reiter: Not too difficult except you add the solvent and when you have as much solvent as that present in such a system, you have to do something about it—or not sell them. And if you want to do something, you get back to the protective coating because you need stability.

Chairman: There are several other questions for you, Mr. Reiter. What can be done to prevent the blocking of PVA coated paper at high humidities—say 100°F?

Mr. Reiter: By PVA I imagine they mean polyvinyl acetate. One hundred degree heat is not too tough on emersion but again these things were designed for adhesive and binding purposes and must be modified to give higher humidity resistance. You can do a number of things. You can add a hard material—a type of starch or polyvinyl—something that will tend to cover over the film of the resin. We have had occasion to prepare solutions and emulsions of identical resins and we find the solution blocks out lower and the presence of the emulsifying agent helps a lot in antiblocking properties. This won't be answered as far as humidity goes, until these agents are of themselves water resistant.

Question: What plasticizer is used for internal plasticizing?

Mr. Reiter: That is not the first time this has been put to me or other people in the organization. At the present time, as you may suspect, we are not divulging what the monomer is. The action is similar to that in the monomeric plasticizers. It imparts properties that have flexibility, etc.

Question: What methods of testing for greaseproofing were used?

Mr. Gold: When we first started working with this, we began using the TAPPI specifications but shortly discarded them because we didn't feel they were typical of what the people in the field wanted. We used a hybrid specification embodying principles we felt were good, severe fold tests with the TAPPI specifications. We use a turpentine solution which has been standard but which everyone today feels is not a true representation of the actual test. We feel, like a good number of converters today that the only true test of greaseproofness is the contact test with the materials you are going to package.

Question: Is there any relationship between particle size in emulsions and retention?

Mr. Reiter: I'd like to ask that question myself. I think the people who have had experience in beater additives can better answer this than the National Adhesives Co. because we have not been active in this and, as only emulsion suppliers, I don't know everything about the paper business. I would appreciate it if someone who has done beater additions could enlighten us on this matter of particle sizing.

We saw from Mr. Rånby's talk that the cellulose strings were very small in diameter. What is necessary in a water solution; and if not a water solution, then an emulsion? Do you have to find out empirically or do you have good theory and pictures to show us what is necessary?

Chairman: Has anyone worked with beater additions and could answer that? The relationship between particle size of the emulsion and the retention of the resin by the fiber in beater additions. Is there any relationship between the particle size and the retention?

Answer: I think we found it wasn't the particle size of the emulsion but of the precipitant. With the larger particles, you get good retention but the efficiency is poor; but if you precipitate in small particle size you get little lower retention for the resin that was retained but in other ways it was better.

Mr. Davenport: I might be able to answer that partially by analogy. We have been carrying on work with rosin sizing paper and we have found the maximum efficiency for the rosin particles to be about two microns. We found some of our papers with very low sizing and we assumed we were not getting the covering power of the rosin into the sheet of paper. So we analyzed those sheets for rosin and strangely enough the papers that had the highest rosin content were the poorest sized. In other words, we lost probably some of our rosin in the white water in the well-sized sheet and the particles that stayed covered the fibers more adequately and gave better sizing than when they were agglomerated and all the rosin stayed in the paper, so we didn't get sizing.

Question: I'd say that was the same thing.

Mr. Greenman: I think he is right.

Question: Can paper be impregnated by the application of resin by an applicator roll before the paper enters the driers on a papermaking machine?

Mr. Reiter: As you might suspect, I want to temper my talk

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by saying we have not had very much experience in this field and the experience we do have indicates this might be a reasonably difficult job. It does have the property of being soft and temperature sensitive. I won't say it can't be done but we haven't seen it done.

Mr. Aid: I have no experience but I think some people saturate the web before it is dried.

Chairman: I don't know whether that has anything to do with it.

Mr. Pullman: I might just add to that last question. I have witnessed the application of thermoplastic resin emulsions on the paper machine that has been running on lightweight stock through the drier section but I strongly believe on heavier stock the temperature of the paper would dissipate this rapidly and you'd have to have a very light sheet.

CHAIRMAN: I'd like to call on Joe Aid of the Robert Gair Co.

JOSEPH AID: I am primarily on this subcommittee, I assume, because I represent the paperboard industry—not the paper industry and, in the case of our particular company, our products—the products from our board machines are almost entirely used and converted to packaging—whether folding carton stock or corrugated.

The industry as a whole is looking for new outlets for the products of their machines, some of which have been stepped up in production capabilities and for the new installations made in the last 10 or 15 years.

We realize in the industry there are ways of finding outlets for our products other than the redesigning of the carton or merely waiting for the birth rate to increase the utilization of plastic materials with paperboard. We know it has great potentialities and they are complementing each other more and more everyday.

As compared to the paper industry, which I was associated with for a number of years before getting into the paperboard industry, I think our progress is a little slow due primarily to the fact we lack commercial and experimental equipment to work with plastic materials. Also, our technical assistance is on a smaller scale as compared to the amount of paperboard manufactured today and the amount of paper. Also, oddly enough, we get a lot of inquiries for new types of products but we find a great reluctance on the part of the customer to pay for it. Paperboard is comparatively cheap and the items going into the packages are cheap and sometimes they don't care to get the characteristics we know we could build into the paperboard.

In several instances I have had requests for paperboard with VPI coated stock. They would like to have it but don't want to pay anything additional for it and that makes it a tough job when you are working with materials that cost 3 and 4¢ a pound and start to buy resinous materials for 30 or 40¢ a pound and the customer doesn't want to pay for it.

Then we find the results of a lot of you gentlemen, particularly in the chemical industry, cannot be picked up from the paper industry and brought back to the paperboard industry and find a ready application for it. It is a little different problem—handling paperboard than paper, particularly when you are talking about coating. You normally don't have a uniform product to start with and probably have a rough surface. The problem is a little more complicated in our industry.

I jotted down here a few examples of what I think is the current interest in problems that call for the utilization of plastic materials: functional coatings would be one of greatest interest. Under that classification we have moisture vaporproof barriers, antiskuff surfaces and antistick surfaces and greaseproof or grease-resistant coatings. We have a need for a specialized or a special adhesive. In some instances we can take a paper product and coat it with a plastic material and laminate it to our board. Then we make a carton out of it and we have the problem of sealing. We also realize there is a great potential in increasing the strength of paperboard by the addition of various resin materials. We have a need in the industry for a material that will size a board on the alkaline side without too adversely affecting the characteristics you get manufacturing a board of that type. Printing inks create an outlet for the use of new plastic materials—at least new in that field. In the corrugated field there has been considerable effort applied to trying to improve the vertical compression or making a corrugated board to stand high humidity conditions that you would find during times of refrigeration. There again plastics certainly have a chance.

I might state in closing that I think you will find industry more product-minded and receptive and you will find more technical men going into the work with the representatives of the manufacturers of the plastic materials to help out the progress in the paperboard industry or the carton manufacturers.

Our company is manufacturing an all-plastic carton. That is a folding carton. I might say as yet the best film for that particular job at present, which will permit people to buy it, has not yet been found.

Mr. Reiter: For grease-resistant values necessary, what weight polyvinyl acetate would you use?

Mr. Gold: Our tests referred to flat surface or fold, which do you mean?

Chairman: On flat surface I presume.

Mr. Gold: On flat surface with starch, we found for grease resistance that the highly chlorinated starches appeared to give the best grease resistance. If I had to try to give you an approximate figure, I would say in the range—flat—of about 25 lb. per 3000 sq. ft. to give greaseproofness or turpentine resistance.

If you prefer to make tests with contact oils such as Mazola oil, you could get away with a range of 15 lb. for 3000 ft. approximately and that would give good results from several minutes to several hours.

A straight 100% polyvinyl acetate polymer on a chipboard gave 30 minutes plus. We found that we could cut down the coating weight to about 4 to 6 lb. and for the internally plasticized type we have put on 2 to 4 lb. using the air knife on Manila board and got in excess of 5 hr. turpentine resistance on the flat surface and in the range of 300 hr. resistance to oil.

CHAIRMAN: I would like to say the men here and those who have cooperated with us are quite cognizant of the problems that face the plastics-paper industry field. There are many, many problems that haven't been touched upon but we hope through the year some of these will be discussed. I am thinking in terms of frictional stability of latices. I know there are many methods used by converters to modify the latices for the purpose of utility but I don't think there is any scientific, sound approach. It has been largely a hit-and-miss, trial-and-error thing. There must be some method or means of evaluating friction stability. I feel that enters into the matter of retention, migration, uniformity and I also feel that we in the consuming field must have good standards for measuring the compatibility of resins with other type products—proteins, carbohydrates, etc. We should have better methods for measuring the predictability of the age characteristics of the resin system.

I certainly want to thank all of you who have taken part in the session.

MR. JAHN: Before you leave, I would like to thank everybody who participated in the program—the chairmen, the various speakers for their work and efforts to make this meeting a success—and also thank all of you for coming here.

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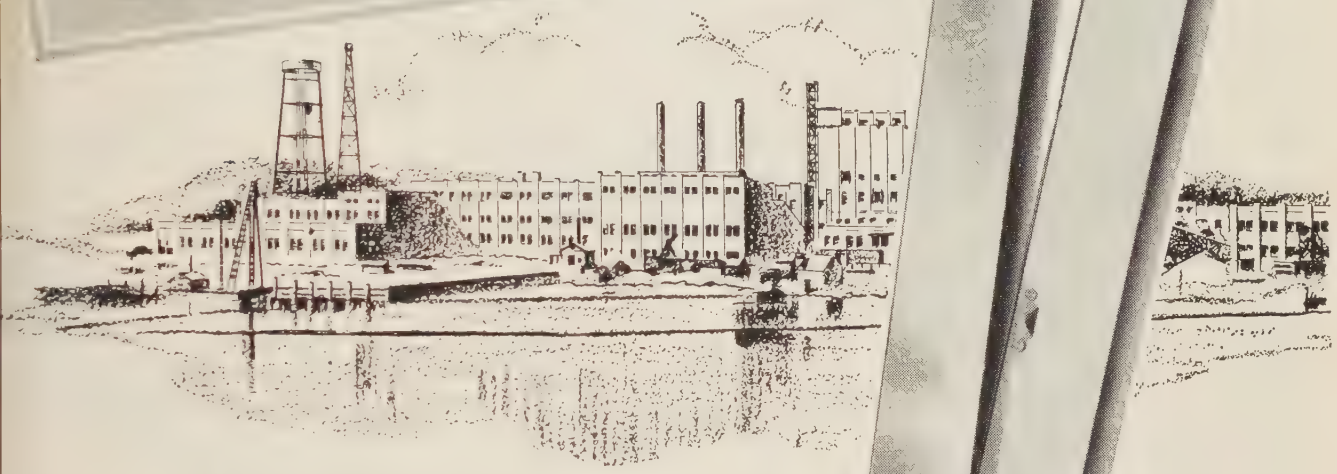

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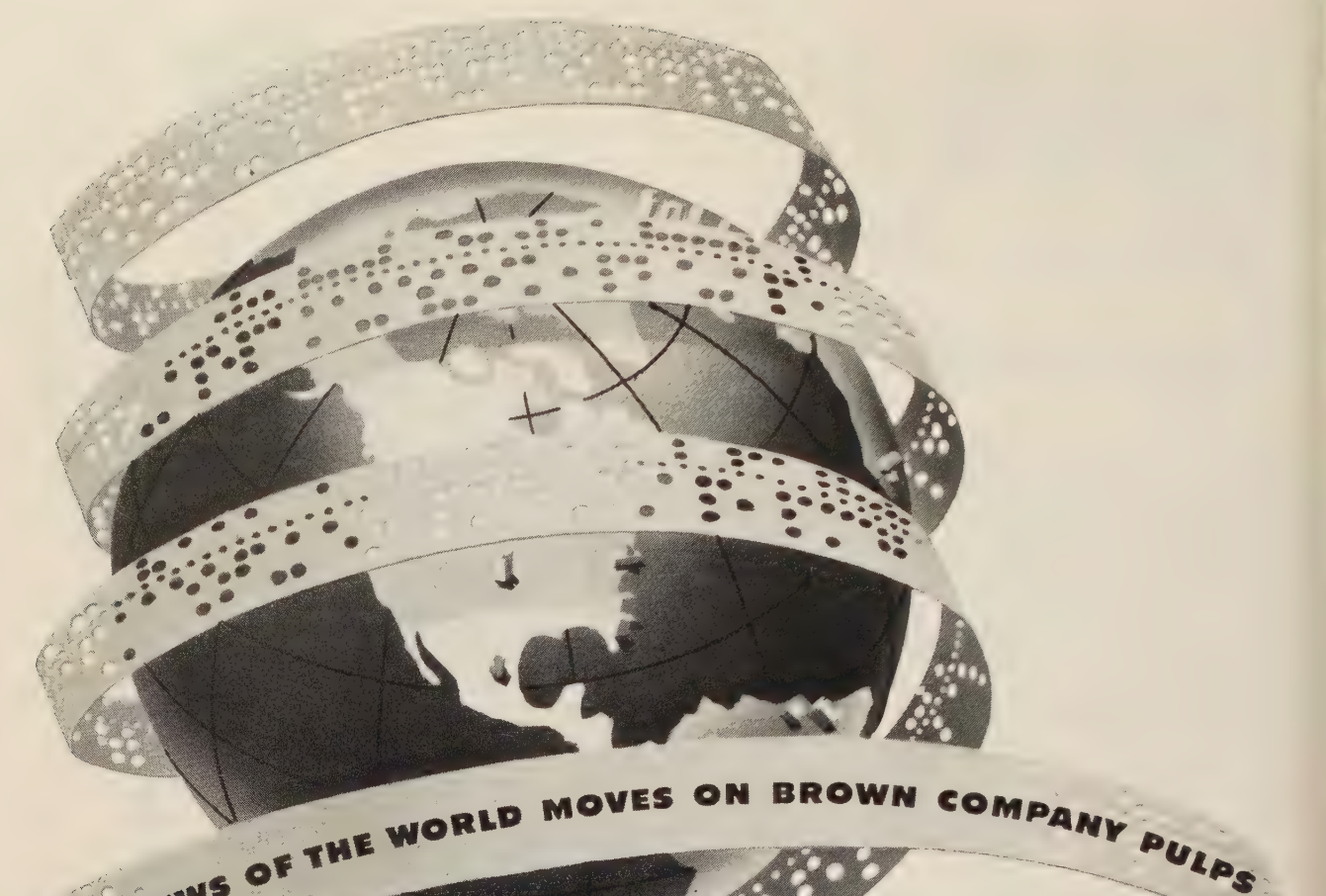

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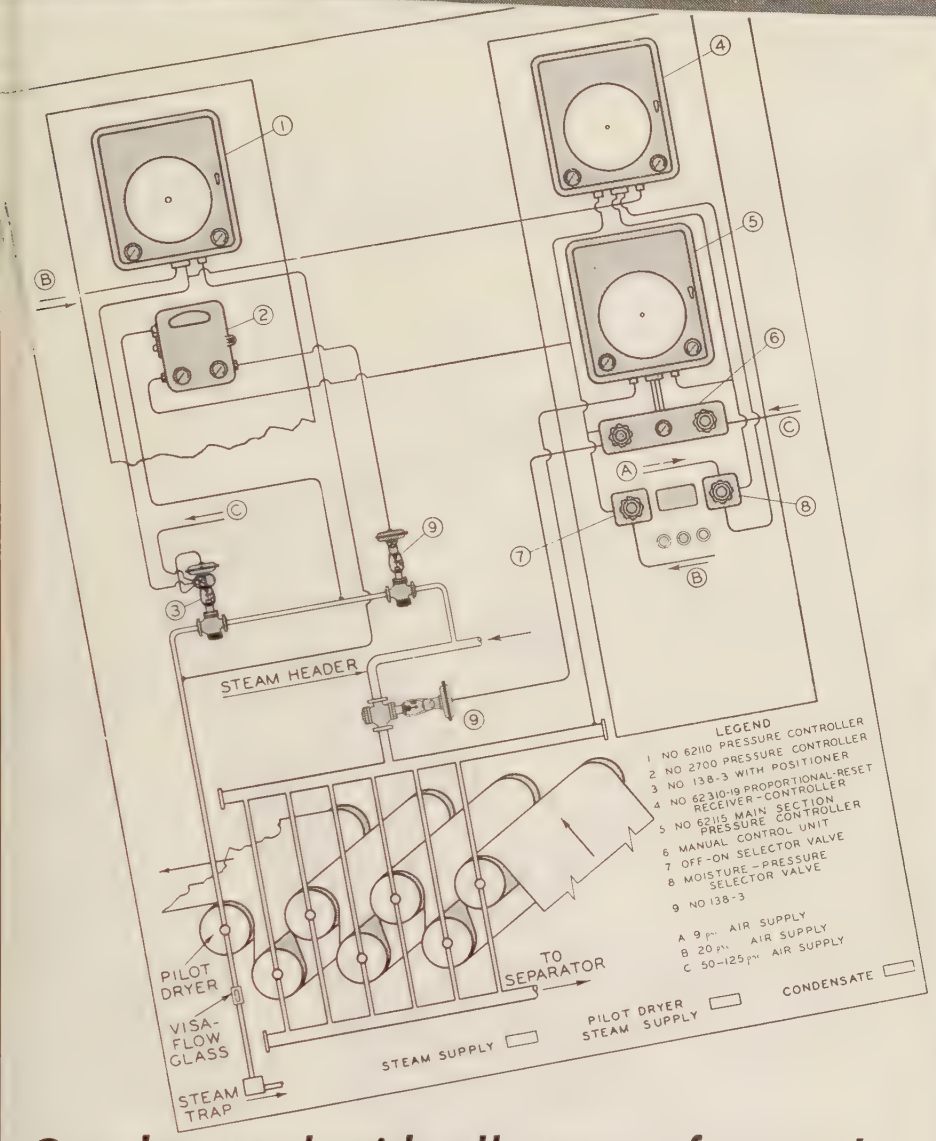

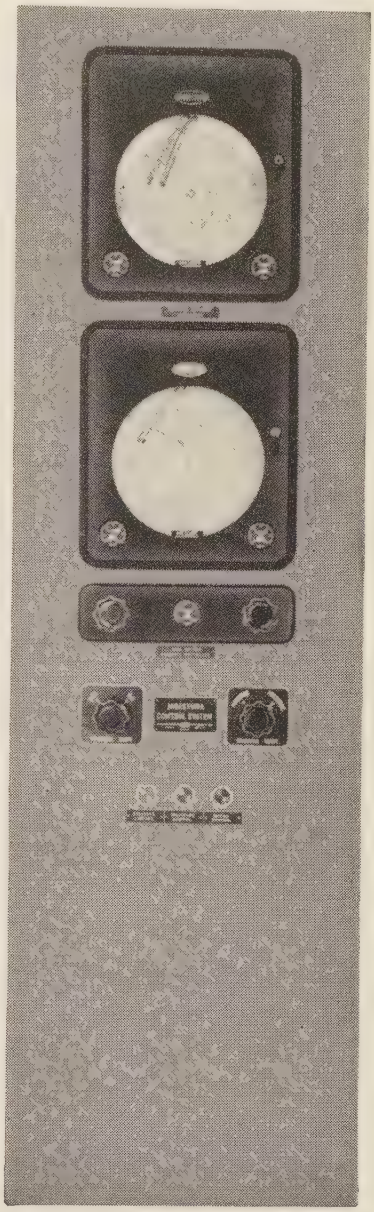

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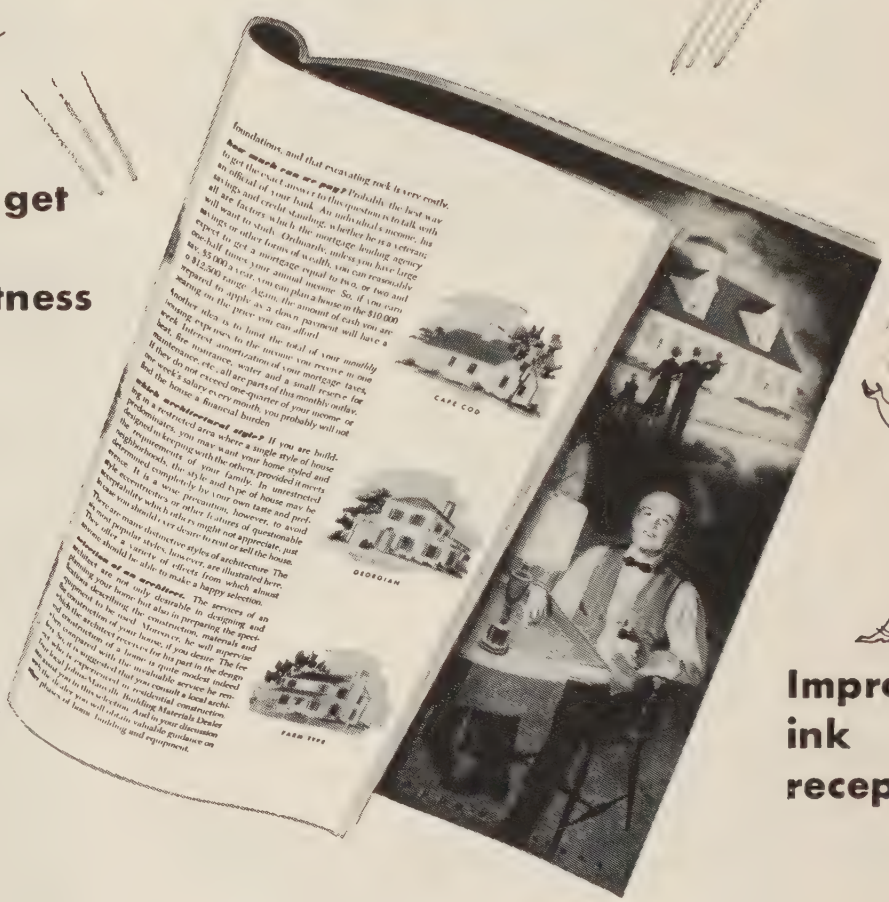

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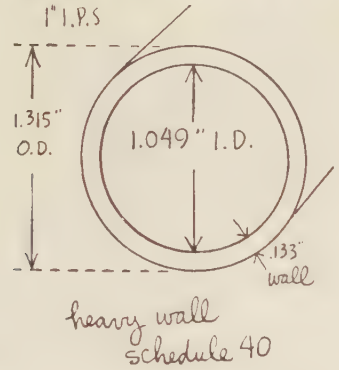

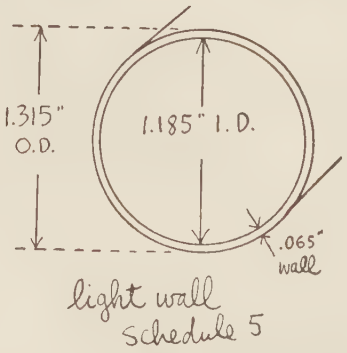

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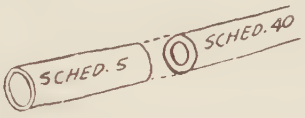

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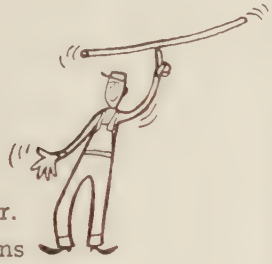

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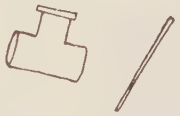

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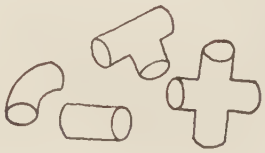

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Hastelloy Alloy F—A New Corrosion-Resistant Alloy for Lined Digesters

MERRILL A. SCHEIL

Hastelloy alloy F is a new corrosion-resistant alloy based on the nickel-chromium-molybdenum-iron system with a balanced chemical composition. The alloy contains the following essential elements: carbon, 0.08% max.; chromium, 21–23%; nickel, 44–47%; molybdenum, 5.5–7.5%; and columbium and tantalum, 1.75–2.5%. The alloy possesses good resistance to pitting, stress-corrosion cracking, and crevice-type corrosion. The fabrication properties of the alloy are satisfactory for welded construction and it is produced in sheet, plate, and bar form. The mechanical and physical properties of the alloy are somewhat similar to the austenitic stainless steels giving the alloy adequate ductility for forming and welding in the construction of lined vessels. The outstanding application of this new alloy has been in lined digesters used for preparing sulphite pulp. Exposure tests of the alloy in alkaline digester service indicate that it may have desirable properties for use in both acid and alkaline digester service.

A NEW corrosion-resistant alloy, based on the nickel-chromium-molybdenum-iron system has been available for testing for 3 yr. It was developed during a long-range, alloy research program on corrosion and heat-resistant alloys sponsored by the Haynes Stellite Co. at the Union Carbide and Carbon Research Laboratories, Inc. It is designated as Hastelloy* alloy F and has the following balanced chemical composition:

Carbon	0.08% max.
Manganese	1.00–2.00%
Phosphorus	0.040% max.
Sulphur	0.030% max.
Silicon	1.00 max.
Chromium	21–23%
Nickel	44–47%
Molybdenum	5.5–7.5%
Columbium + tantalum	1.75–2.5%
Tungsten	1.00 max.
Cobalt	2.50 max.
Copper	0.15 max.
Iron	Balance

Extensive laboratory tests have indicated that Hastelloy alloy F possesses corrosion properties which extend the field of application for nickel-chromium-molybdenum-iron alloys. The alloy possesses good resistance to pitting and stress-corrosion cracking in chloride solutions. The high chromium and molybdenum contribute to the high pitting resistance and it is believed that the high nickel makes the alloy essentially resistant to stress corrosion cracking susceptibility. It has shown especially interesting possibilities as a lining material for sulphite digesters (*1*), and numerous tests conducted by the A. O. Smith Corp. have demonstrated that the fabricating properties of the alloy are satisfactory for the construction of lined vessels. The outstanding application to date of this new alloy has been in lined digesters used for preparing sulphite pulp.

CORROSION-RESISTANCE PROPERTIES

Sulphuric Acid

The resistance of Hastelloy alloy F to boiling 10% sulphuric acid is high as shown in Table I, but it falls rapidly as the concentration of the acid rises above 20%. The data in Table II show that the alloy has good resistance to air-free sulphuric acid at 176°F. up to about 30% concentration. As a result of its high-chromium content, the passivity of Hastelloy alloy F is greatly increased if air or oxidizers, particularly dissolved iron and copper salts other than halogens, are present in the acid. Corrosion rates in boiling sulphuric acid may be somewhat erratic due to the complex manner in which the acid decomposes in contact with the metal and to the presence of small amounts of dissolved copper and other inhibiting impurities.

The influence of welding and heat treatment on sulphuric acid corrosion resistance is shown in Table III. The structural changes occurring at temperatures below 1800°F. do not affect the corrosion resistance of the alloy in this medium.

Boiling 65% Nitric Acid

Hastelloy alloy F tends to exhibit an ascending corrosion rate with time, and it is normally less resistant to boiling 65% nitric acid than the 18–8 type steels.

In order to characterize the effect of welding and heat treatments on sensitization of Hastelloy alloy F, the standard boiling 65% nitric acid test was used and the alloy is shown to be sensitized after slow cooling from the range 1500 to 1100°F. Sensitization in the heat-affected zone due to welding is barely noticeable in the as-welded condition but leads to pronounced sugaring in the heat-affected zone after 1100 and 1200°F. treatments and a general sugaring after 1300°F. At 1600°F. and above, general corrosive attack occurs and corrosion rates decrease with increasing temperatures, ultimately reaching the rates of the original annealed structure. Stress relieving at 1000°F. gives more desirable corrosion rates than stress relieving at higher temperatures. Data for stress-relieving treatments are shown in Table IV.

5% Ferric Chloride Plus 10% Sodium Chloride

Chromium and molybdenum are the most effective elements in reducing the pitting action of a 5% ferric

Merrill A. Scheil, Director of Metallurgical Research, A. O. Smith Corp., Milwaukee, Wis.

*Registered trade name of Haynes Stellite Co., a division of Union Carbide and Carbon Corp.

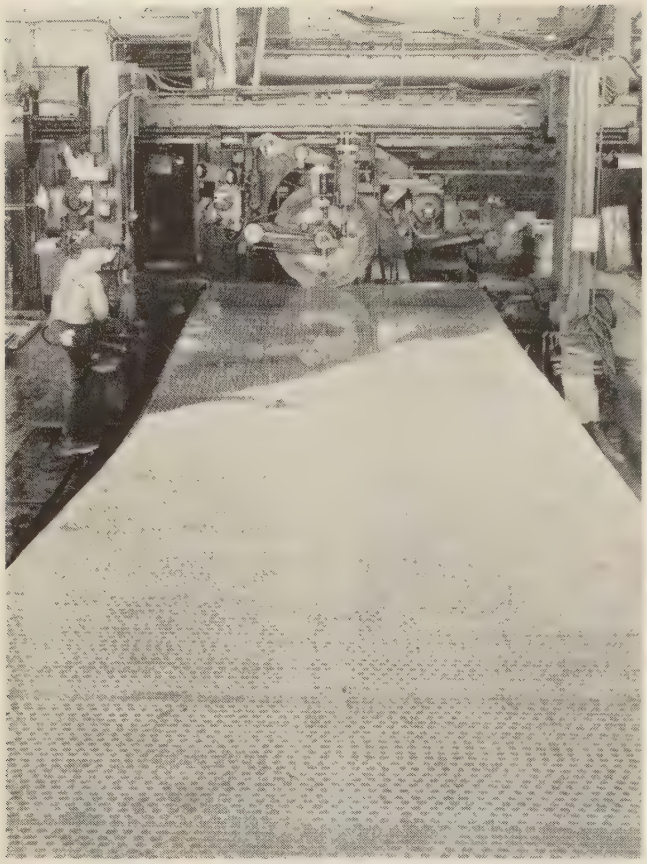


Fig. 1. Production spot welder used for resistance welding alloy sheets to carbon steel backing

chloride plus 10% sodium chloride solution. Hastelloy alloy F was designed to resist such action and has good resistance to pitting. Usually satisfactory resistance in a 72-hr. test period at room temperature is demonstrated from either welded specimens or stock under adverse conditions of heat treatment. When maximum resistance to pitting is required a solution anneal at 2125°F. is recommended.

Sea Water

In tests of welded and unwelded Hastelloy alloy F exposed to sea water at the International Nickel Co.'s test sites in North Carolina it was reported that after 6 mo., the alloy was relatively free of pitting; however, it was found susceptible to under-gasket corrosion. After 25 mo. exposure no further pitting had taken place and the original pits had not enlarged significantly.

Crevice Corrosion

Tests of Hastelloy alloy F in close contact with either type 347 stainless steel or Inconel have been made in the vapor zone and liquid zone of several alkaline digesters. After a period of 1 to 2 yr. alloy F has shown no pitting from the action of the crevice.

Table I. Resistance of Hastelloy Alloy F to Boiling Sulphuric Acid in Solution-Annealed Condition

Acid concentration, %	*Inches penetration per month*			
	1st 48-hr. period	*2nd 48-hr. period*	*3rd 48-hr. period*	*4th 48-hr. period*
10	0.00189	0.00143	0.00274	0.00131
20	0.0043	...	...	...
50	0.0366	...	...	...

Table II. Influence of Acid Strength on Corrosion Resistance of Solution-Annealed Hastelloy Alloy F in Air-Free Sulphuric Acid at 176°F.

Strength of acid, %	*Inches penetration per month*		
	1st 48-hr. period	*2nd 48-hr. period*	*Av.*
10	0.00027	0.00035	0.00031
30	0.00066	0.00061	0.00064
50	0.0105	0.0145	0.0125
65	0.0104	0.0182	0.0143
77	0.0096	0.014	0.0118
90	0.0235	0.0326	0.0282
96	0.0089	0.013	0.0109

In the application of the alloy, precautions should be taken in the design of equipment to minimize crevices and contact areas which can form regions of low-oxygen concentration.

Stress Corrosion Tests

Laboratory tests consisting of Hastelloy alloy F specimens strained and stressed were exposed to boiling 42% magnesium chloride solution and to strong concentrated alkaline liquors at temperatures 300 to 350°F. The experiments with concentrated white liquor were conducted under pressure of about 125 p.s.i. Stresses equal to approximately the yield strength of the alloy were applied and no cracking has been observed in over 500 hr. of exposure.

In service tests in alkaline kraft digesters under conditions that will crack 18–8 steel, Hastelloy alloy F appears to be extremely resistant to stress corrosion cracking.

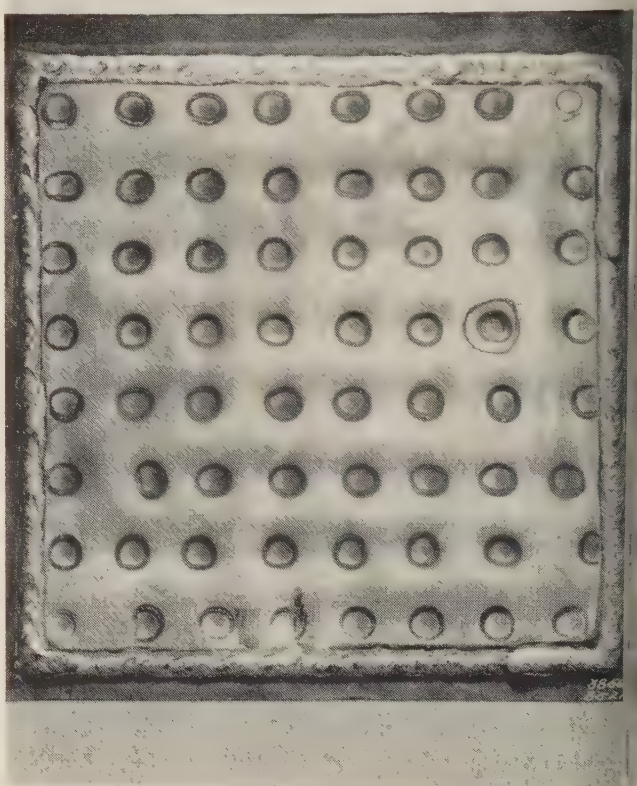


Fig. 2. View of typical burst test plate following hydrostatic testing to failure

ble III. Influence of Welding on Corrosion Resistance of Hastelloy Alloy F in Boiling 10% Sulphuric Acid

Condition of metal	Inches penetration per month		
	1st 48-hr. period	2nd 48-hr. period	3rd 48-hr. period
velded—solution-annealed	0.00146	0.00075	0.00042
ution-annealed, as-welded	0.00172	0.00125	0.0010
	0.00167	0.00185	0.00148
ution-annealed, as-welded + stress-annealed 2 hrs at 1600°F., air-cooled	0.0019	0.00128	0.0014
	0.00151	0.00138	0.00126

MECHANICAL PROPERTIES

olled, solution annealed sheet has adequate duc-ity for intricate cold-forming operations and is about ough as the austenitic stainless steels. The tensile yield strength are 100,000 and 50,000 p.s.i., re-tively, with elongation of 40 to 50% in 2 in. as an-aled or after stress relieving at 1000°F. Prolonged ating at 1200 to 1600°F. is not recommended due to e lowering of toughness. Short-time elevated tem-rature tensile data show a decrease in ductility in the nge of 1300 to 1600°F. and severe hot-forming opera-ns in this range should be avoided.

PHYSICAL PROPERTIES

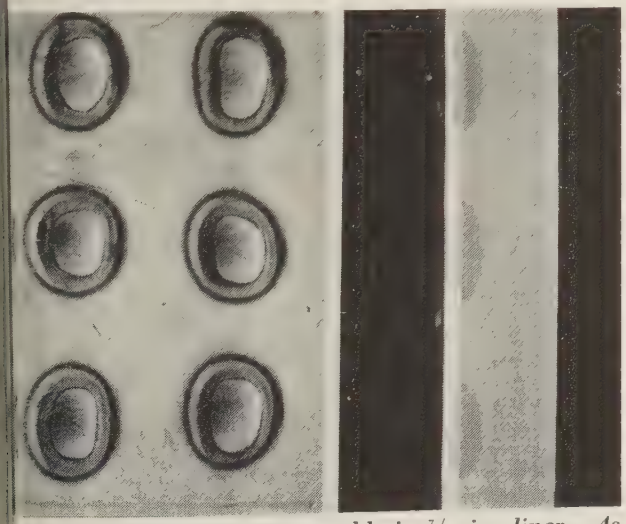
The alloy has electrical resistance somewhat higher an 18–8 steel, indicating favorable spot welding char-teristics and its thermal expansion characteristics e about 10% lower. It is nonmagnetic, has a thermal nductivity about the same as 18-8 stainless steel, d the Young's modulus approaches that of ordinary eel.

APPLICATIONS

Experience with Hastelloy alloy F in service and oratory tests would indicate that the alloy has de-able properties for extensive use in both acid and aline digester service.

d Digesters

Alloy F has been subjected to more than 3 yr. service



3. Cross section of spot welds in 7/64-in. liner. As -welded surface and cross section with 7/64-in. thick Hastelloy alloy F

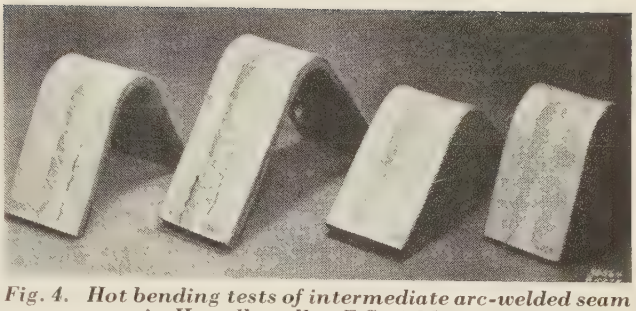


Fig. 4. Hot bending tests of intermediate arc-welded seam in Hastelloy alloy F Smithlining

in the top vapor zone of a sulphite digester, using strong cooking liquor with about 10% total SO_2, with excellent results. The F alloy was selected after a year's testing program of different alloys to combat the pitting attack taking place on a type 316L spot-welded Smithlining. The type 316L alloy began to show pitting after 1 yr. service. Strips of 4-in. wide alloy 7/64-in. thick were applied to the stainless steel lining by butt welding the strips in a herringbone pattern. In this manner short down time periods were used to repair the areas of severest attack. The welding was performed entirely by mill personnel and each strip was air tested for tightness before going on stream. No leaks have developed in this repair and the alloy is showing no pitting or other forms of corrosion even though it is a partial lining.

More recently a scale condition developed in the liquid portion of this digester and developed a heavy deposit in the bottom cone. The scale which is principally calcium sulphate remained in contact with the type 316 stainless steel lining for about 1 yr. and when it was removed revealed extensive pitting of the type 316L alloy. Parts of the cone have been strip lined with Hastelloy alloy F in a fashion similar to the top head and at a recent inspection have an excellent appearance.

The information available at present is not conclusive, but the observations indicate a satisfactory behavior for Hastelloy alloy F for a severe pitting condition where the austenitic chromium-nickel-molybdenum alloys have experienced pitting.

Alkaline Digesters

Several field exposure tests have been made under severe service conditions in vertical stationary alkaline digesters using a variety of pulping woods and cooking conditions. Hastelloy alloy F coupons were attached to the walls of several alloy lined digesters so that specimens were exposed to liquid and vapor conditions. Some of the digesters had original linings of type 347 and Inconel. After the specimens had been exposed for a period of 1 to 2 yr. they were sampled and at the time of removal a probed sample of the original digester lining was removed so that a comparison of the alloys could be made. In every instance of exposure it was found that the vapor condition was more corrosive to the alloys than the liquid zone.

Hastelloy alloy F had a corrosion loss measured by micrometer thickness of the coupons before and after test of 3 mils per yr. (0.003 i.p.y.) max. in the vapor zone and 2.5 mils per yr. (0.0025 i.p.y.) in the liquid zone. This was the highest rate determined for any of the tests on Hastelloy F. The alloy was free of scale

Table IV. Corrosion Resistance of Hastelloy Alloy F Welded and Stress Relieved in Boiling 65% Nitric Acid (12 Gage Sheet—Metal Arc Welded)

Condition of metal	Inches penetration per year											
	Stock						Welded joint					
	1st	2nd	3rd	4th	5th	Av.	1st	2nd	3rd	4th	5th	Av.
Annealed or as-welded	0.012	0.011	0.010	0.010	0.011	0.011	0.013	0.013	0.016	0.017	0.020	0.016
1000°F.—2 hr. F.C.	0.013	0.011	0.010	0.012	0.014	0.012	0.012	0.013	0.016	0.016	0.018	0.015
1100°F.—2 hr. F.C.	0.012	0.011	0.011	0.018	0.021	0.015						
1200°F.—2 hr. F.C.	0.025	0.142	0.232	Stopped								
1000°F.—8 hr. F.C.	0.013	0.011	0.011	0.013	0.017	0.013	0.012	0.014	0.018	0.018	0.024	0.017
2000°F.—1/2 hr. A.C. + 1000°F.—2 hr. F.C.	0.012	0.018	0.035	0.050	0.061	0.035	0.012	0.014	0.023	0.028	0.040	0.023

Fig. 5. Hot forming tests at 1650, 1800, and 2000°F. of spot-welded Hastelloy alloy F around a 10-in. i.d. punch

in the vapor zone, but covered with calcite scale in the liquid zone. No pitting or cracking was observed on the service surface after cleaning the samples and no intergranular attack was observed at the surface when a section was polished and examined with the metallurgical microscope.

Type 347 stainless steel (18–8 + Cb) under the same conditions showed a micrometer thickness loss calculating to 14 mils per yr. (0.014 i.p.y.) in the vapor zone and a very low rate less than 1 mil. per yr. (0.001 i.p.y.) in the liquid zone. This stainless steel in other exposure conditions has shown as high as 22 mils per yr. (0.022 i.p.y.) in the vapor and 14 mils per yr. (0.014 i.p.y.) in the liquid zone. The attack varies from a smooth general corrosion of the alloy to a pitted condition with strong susceptibility to stress corrosion cracking.

Inconel Smithlining under the same conditions as Hastelloy alloy F has shown almost three times the loss in thickness in the vapor zone from micrometer measurements. Some of this alloy has pitted in service and the corrosion rate in the pits during the first year of service was as high as 7 to 8 mils per yr. for the vapor zone. Recent examination revealed Inconel with a maximum corrosion rate of 9 mils per yr. (0.009 i.p.y.) with some rates ranging from 0 to 2 mils per yr. (0.000 to 0.002 i.p.y.) in the vapor zone. No measurable loss was found in the liquid zone. Inconel has shown no tendency to crack from stress corrosion conditions which crack stainless steel. Scaled and unscaled areas of Inconel develop in the liquid zone of the digester and examination of either surface has not revealed any tendency toward pitting.

The indications from service experience to date are that Inconel appears entirely satisfactory for the liquid zone with some reservations on its use for every type of vapor zone condition because of pitting. More service experience in the locations of light pitting will in time prove whether this will subside or continue.

From the limited experience with Hastelloy alloy F, it would appear that this alloy offers a remarkable combination of properties for the new duplex pulping processes requiring weak or strong acids, or sulphurous

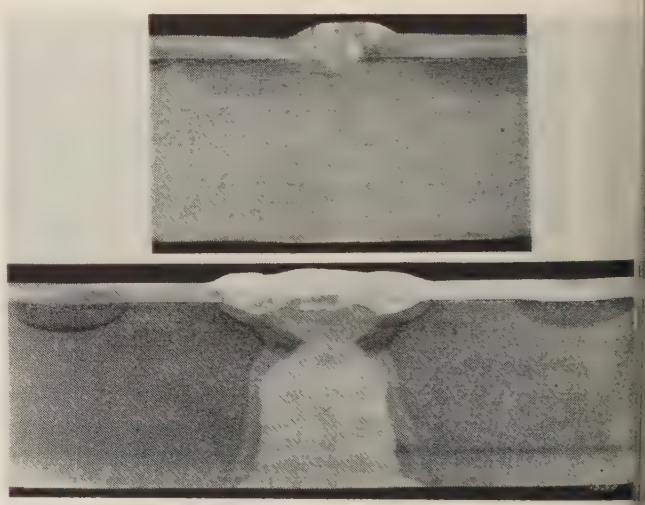


Fig. 6. Macroetched cross sections of intermediate an main alloy weld deposited seams used to join the linin

Table V. Mechanical Properties of Hastelloy Alloy F Solution Annealed, Welded and Heat Treated

Condition of metal	Tensile strength, p.s.i.	Yield strength, (dividers), p.s.i.	% elongation 2 in.	Bend degrees	Hardness Rockwell B
As-welded (14 gage)	104,900	41,300	35.5	180	98 Weld
As-welded; heated 2 hr. at 1000°F.[a]	108,100	39,100	30.5	180	85 Weld
As-welded; heated 2 hr. at 1200°F.[a]	109,500	54,600	34.0	180	
As-welded; heated 2 hr. at 1400°F.[a]	110,000	54,300	32.5	105	
As-welded; heated 2 hr. at 1600°F.[a]	113,000	48,200	28.5	75	
As-welded; heated 2 hr. at 1800°F.[a]	108,900	50,600	26.5	65	
As-welded; heated 2 hr. at 2000°F.[a]	102,100[b]	45,600	21.5	180	
Unwelded sheet (12 gage) 2000°F.—1/2 hr.[c] + 1000°F.—2 hr.[a]	105,100	50,100	49.0	180	
Welded sheet (12 gage) 2000°F.—1/2 hr.[c] + 1000°F.—2 hr.[a]	102,500[b]	47,600	29.5	180	

[a] All heat-treated specimens were furnace cooled.
[b] Fracture occurred in weld metal.
[c] Heated and cooled between 1/2 and 1/4-in. stainless steel plates.

ble VI. Typical Hydrostatic Tests on Spot-Welded Hastelloy Alloy F for Smithlining

Hastelloy F thickness, in.	*Spot weld spacing, in.*	*Hydro pressure (p.s.i.g.) To bulge*	*To burst*
0.083 (14 gage)	$1^1/_2 \times 1^1/_2$	1200	2600
0.109 (12 gage)	$1^1/_2 \times 1^1/_2$	2000	3200
	$1 \times 1^1/_2$	2100	3500

Material—$^3/_4$-in. ASTM A212 backing plate. Heat treatment—1000°F. 2 hr.—furnace cool after welding.

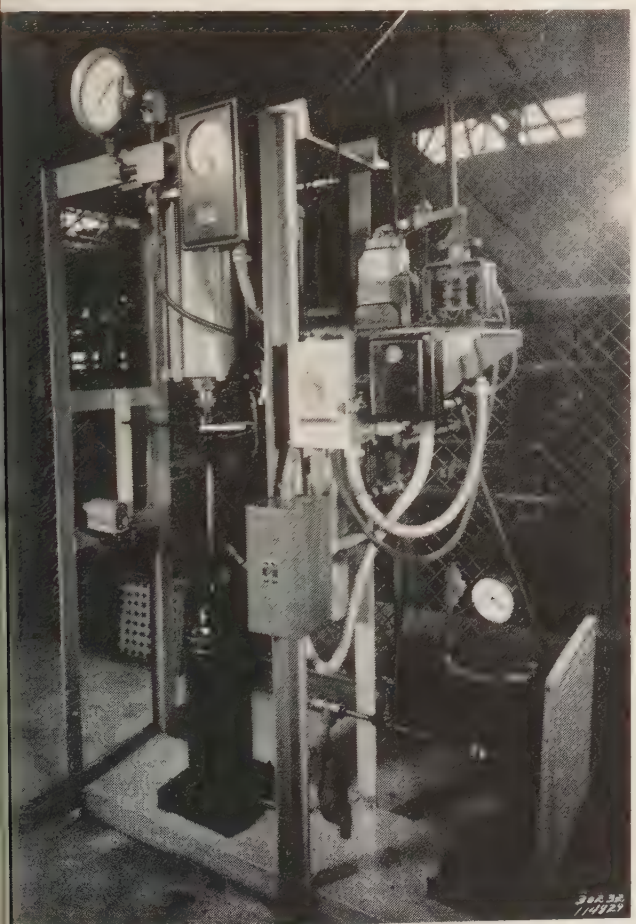
d for the first part of the cook and an alkaline condi- on for the final part of the cook.

One of the difficulties in evaluating a new alloy for ping service is the time of testing. Usually we feel t 3 to 5 yr. is about the shortest time to appraise alloy for all the conditions that exist.

The digester corrosion problem is being actively lied by the TAPPI Digester Corrosion Subcommit- This group would render the industry a great serv- by studying the design variables in the internal ts for a digester. The method of introducing liquor, m, circulation, pump capacity, and velocity all e an influence on where corrosion will occur.

WELDING CHARACTERISTICS

Hastelloy alloy F has fusion welding characteristics ite similar to the high nickel-chromium alloy, In- el. For metal arc welding a coated electrode has en developed by A. O. Smith Corp. with the latest pe lime-ferritic coating which gives exceptionally mooth performance for manual welding. These elec- rodes are satisfactory for all-position welding Three



. 7. Fatigue test apparatus used to produce cyclic pulsation to spot-welded liner

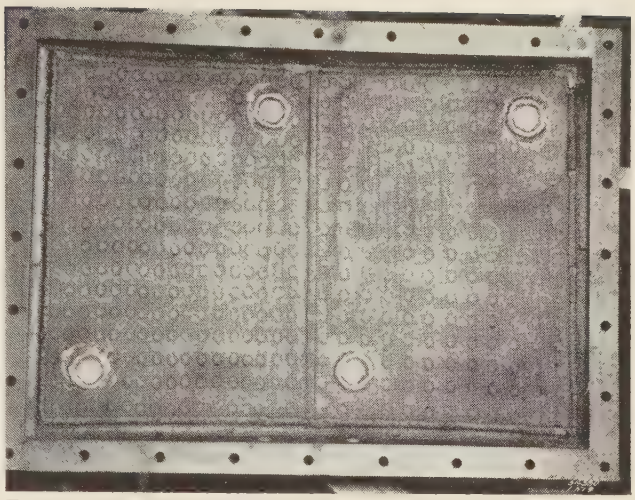


Fig. 8. Thermal shock test plate of Hastelloy alloy F $1^1/_2$ by $1^1/_2$-in. spacing at right 1 by $1^1/_2$-in. spacing at left

electrode diameters are manufactured, $^1/_8$, $^5/_{32}$, and $^3/_{16}$ in.

Hastelloy alloy F can be welded by the inert nonconsummable tungsten arc with either argon or helium gas shielding.

Weld metal of either metallic arc or inert arc is of suitable radiographic quality. The welds are characterized by high ductility in the as-welded condition being comparable in mechanical properties to the parent metal.

As an example of the mechanical properties obtained from metal arc welds, 12 and 14-gage sheet were full penetration welded and subjected to various thermal treatments for tensile and bend properties of the transverse welded joint. Table V shows the developed properties.

A loss in weld ductility is observed through the range of 1400 to 1800°F. on furnace cooling.

APPLIED LINING TESTS

The metallurgical characteristics of Hastelloy alloy F are ideally suited for resistance welding and suggested its use in the Smithlining process for lined pressure vessels for application to the chemical and petroleum industries.

A few of the many tests used to characterize Smithlined Hastelloy alloy F will be described as the results of these were favorable enough to warrant going ahead on large production vessels for severe service to be described later.

Spot Welding Tests

Liner sheets $^5/_{64}$ and $^7/_{64}$-in. were spot welded on the production welders one of which is shown in Fig. 1. Ultimate spot welding conditions are determined by making test plates and seal welding the edges of the lining to the base plate. Through a drilled and tapped hole into the backing hydrostatic pressure can be applied to determine the pressure at which the liner yields (bulges) between spot welds and ultimately fails by shearing of the liner at a spot weld. Some typical hydrostatic tests are shown in Table VI. Figure 2 illustrates a test plate after a typical burst test.

Figure 3 shows the macroetched cross section of spot welds in $^7/_{64}$-in. lining. A fused nugget occurs for each spot weld with a heat-affected zone in the base plate.

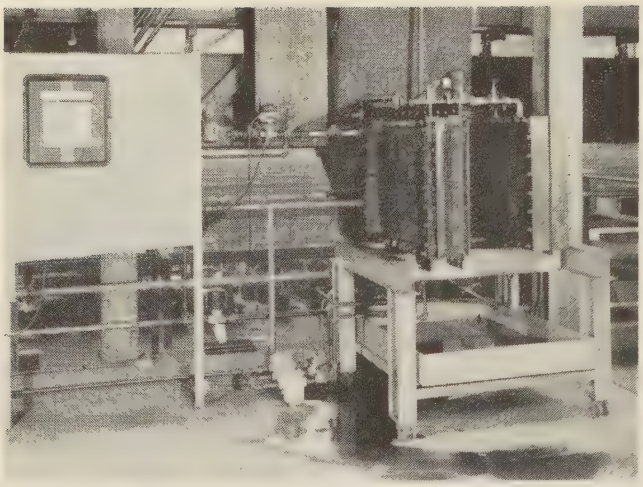


Fig. 9. View of thermal shock testing apparatus with a duplicate pair of test plates

The fusion zone of the spot weld in the Hastelloy alloy F does not penetrate into the carbon steel as is evidenced by the straight line of contact and therefore there is negligible dilution of carbon steel in the Hastelloy alloy F nugget. The Smithlining process does not produce a noticeable indentation or "brinelling" of the liner surface at the spot weld.

The special resistance welding process employed for applied Hastelloy alloy F lining creates a fusion bond between the alloy and carbon steel with a shear strength greater than the tensile shear strength of the alloy. Shear stress ranging from 77,000 p.s.i. at room temperature to 3100 p.s.i. at 2000°F. indicates that the bond strength of the spot welding is adequate for hot forming into detail parts of pressure vessels.

Alloy Welded Seams and Hot Forming Tests

Figure 4 shows hot bending tests at 1000, 1500, and 2000°F. of Hastelloy alloy F spot welded $^{7}/_{64}$-in. thick lining with an intermediate weld seam of metal arc Hastelloy F.

Figure 5 shows hot forming tests at 1650, 1800, and 2000°F. of spot-welded Hastelloy alloy F around a 10-in. punch.

These tests illustrate the ductility of the metal arc-welded seams joining panels of the lining and also illustrate the high shear strength of the spot welding.

The alloy welding for applied Hastelloy alloy F linings will meet all the requirements of Code

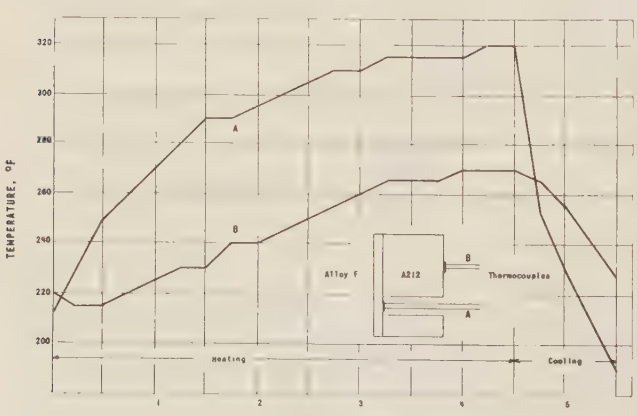


Fig. 10. Average thermal shock cycle for Smithlining $^{7}/_{64}$-in. Hastelloy alloy F on $^{3}/_{4}$-in. ASTM A212, $1^{1}/_{2}$ by $1^{1}/_{2}$-in. spacing

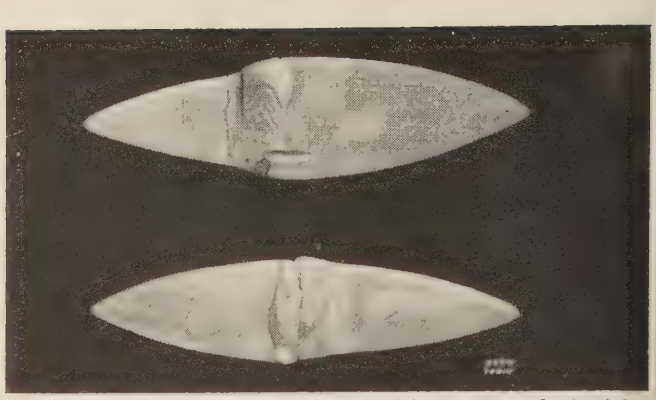


Fig. 11. Probed samples of thermal fatigue cracks in 4-in. wide welded strips with weld and parent metal cracks that form during 2000 cycles of thermal shock testing

Case No. 1078 of the ASME Boiler Construction Code.

Figure 6 illustrates a macroetched cross section through an intermediate liner seam and the alloy weld deposited layers used to cover the main carbon steel weld seams and join the alloy lining.

Fatigue Tests of Smithlining

The apparatus shown in Fig. 7 is a device for producing cyclic pulsation (zero pressure to maximum pressure and back to zero pressure) to spot welds by the introduction of high pressure water back of the lining. An air cylinder is controlled to pump water to a predetermined pressure into the capillary space between the spot welds on a test plate. The hydrostatic pressure is automatically controlled by an electric gage and adjusted to a pressure that creates a breathing of the liner just below the elastic limit of the Hastelloy alloy F. The pulsating action serves to produce a stress concentration at the interface periphery of the spot welds. This test was designed to determine the ultimate electrical conditions for spot welding and in our tests of Hastelloy alloy F we have exceeded 100,000 pulsating cycles at hydrostatic pressure of 750 p.s.i. for $^{7}/_{64}$-in. thick lining with $1^{1}/_{2}$ by $1^{1}/_{2}$-in. spot weld spacing.

Fig. 12. View of Hastelloy alloy F lining in top head of 15-ft. i.d. digester at first service inspection

thout loosening of the spot weld bond. Cycling was erformed at the rate of 750 complete cycles per hour ring test.

hermal Shock Tests of Smithlining

These tests have been performed on production elded plates by heating the applied linings under the ost severe conditions followed by rapid quenching of e lining so that in the test a temperature differen- al between the lining and backing existed during th heating and cooling. The results have indicated very satisfactory performance for the spot welding of any types of alloys.

In the case of Hastelloy alloy F Smithlining, test ates were spot welded and fabricated as shown in Fig. The tests simulated the lining for a 15-ft. diameter igester. Each test plate contained different spot weld pacing of Hastelloy alloy F liner with an intermediate ayer. A heavy steel frame was welded to each test late so as to restrict the movement of the carbon steel acking in heating and cooling. By roll forming the lates to a $7\frac{1}{2}$ ft. radius a cavity was formed between he service surfaces of the lining when the frames were asketed and bolted together.

The thermal shock test consisted of heating the avity with high pressure steam until the lining tem- erature reaches 320°F. Then, by automatic controls, old water is instantly introduced to flush the cavity nd cool the liners rapidly.

Figure 9 shows the apparatus with a duplicate pair of est plates in the test, and Fig. 10 is a plot of the time nd temperature cycle.

Hastelloy alloy F lining as described above has suc- essfully passed 25,000 cycles of severe heating and ooling without any evidence of liner displacement due o creep, with no evidence of bond strength weakening the spot welds, and with no signs of elevated tem- erature fatigue cracks either in the arc welds or spot elds.

pplied Strip Lining

There has been included in our extensive testing ogram of Smithlined alloy liners many tests of strip ining using Hastelloy alloy F strips welded directly the carbon steel in conventional widths between at- chment arc welds.

. 13. World's largest alloy lined digester being assembled for field erection at mill site

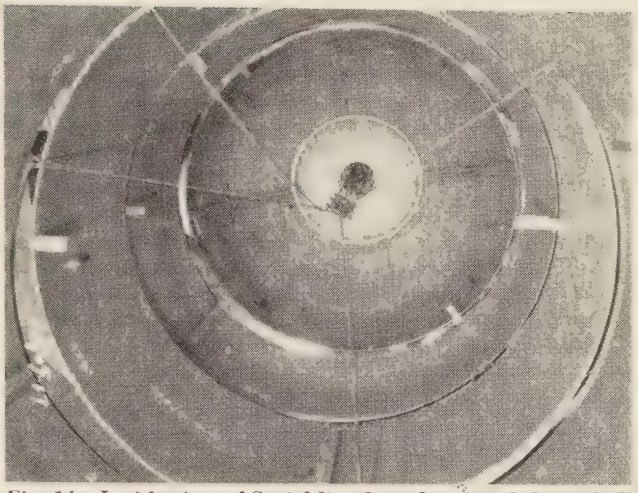


Fig. 14. Inside view of Smithlined top head and three shell section rings being positioned in digester house prior to welding of circumferential field seams

Our tests indicate that there are definite limitations for strip widths in applied linings depending of course on the severity of the thermal conditions in service.

Figure 11 illustrates probed samples of thermal fatigue cracks in 4-in. wide welded strips on carbon steel with weld and parent metal cracks that form during 2000 cycles of thermal shock testing similar to the heating and cooling cycle described in Fig. 10.

FABRICATION EXPERIENCE

The tests that have been described offer substantial evidence for the success of Smithlined Hastelloy alloy F in chemical process equipment.

On the basis of the 3-yr. service tests of Hastelloy alloy F, two digesters have been fabricated with this alloy Smithlining in the top head. One digester is 15 ft. i.d. by 56-ft. 4-in. overall and has been in service about 1 yr. Figure 12 shows the Hastelloy alloy F lining of the top head at a recent service inspection.

The lining is in excellent condition and the Hastelloy alloy F is proving very satisfactory.

The second digester was shop fabricated to half sections of the cone, shells, and top head to facilitate rail shipment and was then field assembled, welded field seams radiographed, stress relieved at 1000°F., and hydrostatically tested. This digester is 19 ft. i.d. and 58 ft. high and pulps 140 tons of wood chips per cook (*2*).

Figure 13 shows the world's largest alloy lined digester being assembled for field erection at mill site.

Figure 14 shows the inside view from the cone of the Smithlined top head and three shell section rings being positioned in the digester house prior to welding of the circumferential field seams.

This digester has been in operation for 9 mo. and the condition of the Hastelloy alloy F is excellent.

Six digesters are on order for magnesium bisulphite service. These will be 17 ft i.d. by 58 ft 0 in. overall. The top heads will be Smithlined with Hastelloy alloy F and the digesters will be field erected at the mill site.

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Alpha-Cellulose from Solvent Extracted Cotton Linters

RALPH F. BURDYNSKI and KENNETH A. KOBE

Cellulose with a high alpha content is produced by digesting cotton linters with a solution of caustic soda. When the cotton wax is removed first by solvent extraction the linters are penetrated quickly and uniformly by the digestant, and the digestion process requires a shorter time, lower temperature, or lower caustic soda concentration. The extracted wax may be recovered easily as a valuable by-product. Raw and dewaxed cotton linters were digested with caustic soda solution in a stainless steel digester. The properties of the cellulose produced from the two materials were determined. Chemical cotton produced from solvent extracted linters shows a definite improvement in quality over that produced from raw linters. A high viscosity chemical cotton can be produced from extracted linters by employing milder digestion conditions than would be possible in the case of raw linters.

Chemical cotton is used principally in the manufacture of cellulose derivatives where its purity high alpha-cellulose content, and viscosity make it ideally suitable. The number of derivatives, as well as their tonnage, has expanded in recent years (*4*), and includes cellulose nitrate, cellulose acetate, and a number of cellulose ethers such as ethyl cellulose, methyl cellulose, benzyl cellulose, hydroxyethyl cellulose, and carboxymethyl cellulose. The latter is finding increased use in such diverse industries as synthetic detergents and petroleum production. A large amount of chemical cotton is used in the production of high tenacity rayon tire cord and for viscose products.

Cotton linters are the raw material for chemical cotton production. They are the short fibers remaining on the cottonseed after the ginning operation. Removal is accomplished prior to recovery of the cottonseed oil by delinting machines, usually in two or three passes through the machine (*5*, *14*). Three grades of linters are obtained: first cut, second cut, and mill run linters. The second cut grade is used exclusively for chemical cotton manufacture.

The object of the digestion process is to remove the noncellulosic constituents of the linters without adversely affecting the cellulose. This is accomplished by heating the linters in the presence of a 1 to 3% caustic soda solution. Heating is done by steam in a digester from which air is carefully excluded. Temperatures up to 350°F. are attained for periods up to 6 hr. (*1*, *4*, *5*, *11*, *14*, *16*). Of the three process variables, temperature, digestion time, and caustic soda concentration, temperature is the most critical for adequate control of viscosity and alpha-cellulose content. The digestion is followed by washing, bleaching, and drying under carefully controlled conditions.

Munson (*14*) gives the following as a typical analysis of raw second cut cotton linters:

Chemical yield of cellulose by digestion	80–85%
Ash	1–1.5
Ether extract	1
Iron	0.06
Lignin (insol. in sulphuric acid)	3
Moisture	6

The noncellulosic impurities may be classified into two categories: those materials, including wax, fats, and pectic substance that are part of the raw fiber and the admixed materials such as hull matter and field trash. Of the two, only the impurities intimately associated with the fiber may be expected to influence the pulping characteristics of the linters. The waxes and fats comprise the bulk of the impurity found in the fiber and with the pectic substance and an open cellulose structure form the primary wall (*6*) which acts as a protective sheath around the cellulose layers of the secondary wall.

Present digestion processes consider the wax as an impurity and it is partially removed by the alkaline digestant as a soluble saponification product. In this role it contributes only to increased caustic soda requirements and to the industrial waste of the plant. Solvent extraction of the linters produces a concentrated solution of the wax in solvent from which it is easily recovered. After further treatment such as bleaching it can be used industrially as a vegetable wax. Tonn (*19*) reports the following composition and properties of cotton wax.

Fatty acids		25%
Saturated	24%	
Unsaturated	1%	
Unsaponifiable matter		69%
Alcohols	52%	
Sterols	10%	
Hydrocarbons	7%	
Inert matter		6%

The principal difference in composition between cotton wax and other vegetable waxes is in the relative amounts of esters and unsaponifiables. Cotton wax contains smaller amounts of fatty acids and larger amounts of free alcohols. As compared to other vegetable waxes, cotton wax is medium-high melting with a consistency similar to beeswax. It has good blending characteristics, and should be satisfactory for use whenever a medium-high melting wax is required.

The object of the present research is to determine what effect the removal of the waxes and fats of the primary wall has upon pulping characteristics of the linters and what improvement in quality of the chemical cotton is brought about.

EXPERIMENTAL EQUIPMENT AND PROCEDURES

Extraction Equipment

The extraction unit employed was one which had been constructed previously for extraction of lint cotton with benzene (*19*). It was modified slightly so that isopropanol could be used as the solvent. The essential

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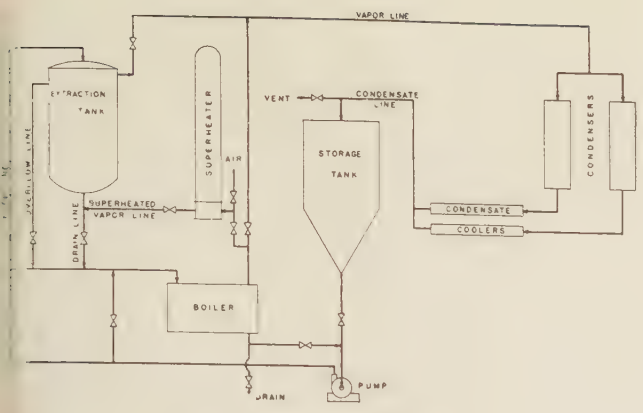

Fig. 1. Extraction unit

Details of the modified pilot plant unit are shown in Fig. 1.

Extraction was batchwise on approximately 50-lb. samples. The isopropyl alcohol was heated to the boiling point and pumped through the overhead line so that it flowed by gravity down through the linters. Additional alcohol was added through the boiler until the linters were completely covered. The enriched alcohol was drained off into the boiler, distilled, and collected in the storage tank, while the wax concentrate remaining in the boiler was withdrawn and stored for future use. The entire cycle was then repeated with fresh alcohol three times more. After the final extraction the linters were allowed to drain for several hours and then isopropanol vapor, heated in the superheater to 220°F., was passed through the linters from bottom to top until approximately 3500 lb. of vapor had been circulated. A stream of warm air at 150°F. was then passed through for 24 hr. to complete the removal of isopropanol and dry the linters.

Digestion Equipment

A laboratory-size rotary digester was constructed of stainless steel, and had a maximum working pressure of 100 p.s.i.g. with a total capacity of 3 cu. ft. The digester was rotated around its longitudinal axis at a constant speed of 6 r.p.m. by means of a gearhead motor and gear drive. The 2-in. hollow stainless steel trunnions were supported in bearing blocks mounted on frame. Linters were introduced through a 5-in. flanged opening and withdrawn, during the course of digestion, through a 1-in. plug valve. A strong caustic soda solution and preheated water were introduced simultaneously through one of the hollow trunnions connected to a distributor pipe, the purpose of which was to spread the solution evenly over the linters. Temperature was maintained to within ±0.5°F. by nichrome wire heater elements wound spirally around the digester and controlled by a Fenwal thermoswitch operating through a relay. Electrical connections to the rotating digester were made through a slip ring arrangement located on one of the trunnions. Details of the digester and parts are given in Fig. 2.

A 7-lb. charge of linters, on a moisture-free basis, and 70-lb. charge of caustic soda solution were used for all digester runs. This filled the digester about half full and ensured good mixing. The linters were placed in the digester and the flange sealed. Nitrogen was admitted through a small bleed valve, located next to the flange, and the pressure in the digester raised to 15 p.s.i.g. The nitrogen was allowed to escape and the purging process repeated three times more. The digester was then preheated to a temperature of 200°F., which was found to be the maximum safe preheat temperature to prevent local overheating of the dry linters. In order to arrive at the desired operating temperature, it was necessary to heat the water to some higher temperature since the temperature of the digester had also to be raised from 200°F. to operating temperature. The water preheat temperature was calculated from the following:

$$0.965W_1(t_2 - t_1) = 0.12W_2(t_1 - t_0)$$

where

0.965	=	specific heat of the caustic soda solution in B.t.u./lb./°F.
W_1	=	weight of water in pounds
W_2	=	weight of digester in pounds = 264 lb.
0.12	=	specific heat of stainless steel in B.t.u./lb./°F.
t_2	=	water preheat temperature, °F.
t_1	=	desired operating temperature, °F.
t_0	=	digester preheat temperature = 200°F.

or as an approximation where W_1 is taken as 62.1 lb.

$$t_2 = 1.53t_1 - 106$$

By preheating the water in this manner, operating temperature was attained within a few minutes of the start of a run. To insure that all oxygen had been purged from the system, a small quantity of the preheated water was allowed to enter the digester before introducing the caustic soda, it immediately flashed to steam and by opening the bleed valve the system was purged of any remaining air. The water was heated in a steel tank fitted with a steam coil and was admitted to the digester, under its own pressure, through a water inlet line. The strong caustic soda solution was transferred from a separate stainless steel tank by steam pressure, entering the hot water inlet line and mixing with the water in traveling through the hollow trunnion and distributor pipe. After transfer of the water and caustic solution was accomplished the pipe connections were unfastened and the digester rotated.

Samples of the linters were removed at approximately hourly intervals by stopping the digester in an upright position and drawing off a sample through the 1-in. plug valve at the bottom, through a sampling tube connected by a screw thread to the plug valve. A stream of cold water was passed through a side arm of the tube and mixed with the linters as they issued from the valve. This served to lower the temperature and dilute the caustic soda solution before the linters came in contact with air. These samples were washed free of caustic soda with tap water, and air dried for several

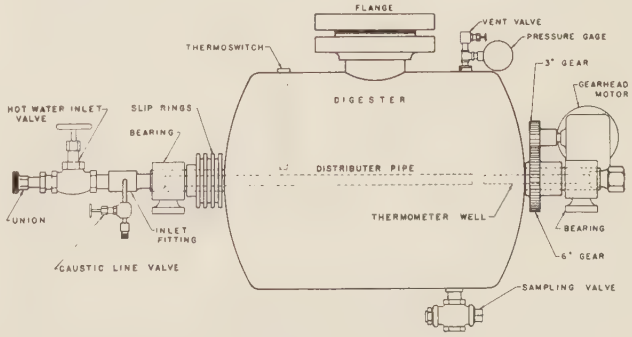

Fig. 2. Digester assembly

days at room temperature after removal of the bulk of the water in a mechanical press. A 20-gram portion of this air-dried sample was selected and placed in an air-tight jar for a minimum of 48 hr. before any determinations were made, assuring that moisture equilibrium had been attained throughout the sample.

Analytical Equipment and Methods

Cuprammonium viscosity was determined by the TAPPI method (*18*) using either 0.5 or 1.0 gram of linters, on a moisture-free basis, in 100 ml. of cuprammonium hydroxide. The cuprammonium hydroxide was prepared by a method originated by Joyner (*8*) and subsequently adopted as standard by the American Chemical Society (*3*), and TAPPI (*18*). The solution after analysis for copper and ammonia was stored in 1-liter brown glass bottles in a refrigerator until used. Linters samples were dissolved by a method suggested by Mease (*13*) which permits use of a larger sample than the TAPPI method of dissolving the cellulose directly in the viscosity tube. A further modification which permitted the introduction of the solvent in the absence of air was developed whereby the calibrated dissolving bottle containing the weighed linters sample and a stainless steel mixing rod was closed with a rubber stopper containing a short 1-mm. capillary tube. The bottle was evacuated through the capillary to 5 to 10 mm. of mercury and flushed with nitrogen four or five times. After a final evacuation of the bottle the cuprammonium hydroxide was admitted through the capillary, filling the bottle up into the tube. The capillary was sealed with sealing wax and the bottle rotated overnight on a mixing wheel from which all light was excluded. The bottles were then placed in a dark thermostat maintained at 20 ± 0.03°C., where they were allowed to reach equilibrium. Viscosity tubes were of the short efflux type described in the literature (*15*) and made to TAPPI specifications. These were calibrated at 20°C. with viscosity reference standards and distilled water. The viscosity in centipoises was computed from the equation:

$$\eta = C(\theta - K/\theta)$$

where

η = viscosity in centipoises
θ = efflux time in seconds
C = viscosity tube constant
K = gravity constant

The average of three separate determinations in different tubes was recorded as the viscosity at 20°C. of the linters at either the 0.5 gram or 1.0-gram concentration. Viscosities were converted to a concentration of 1 gram of cellulose in 100 ml. of cuprammonium hydroxide solution by use of Martin's equation (*12*):

$$\log [\eta] + K[\eta]C = \log \eta_{sp}/C$$

where

$[\eta]$ = intrinsic viscosity
K = constant = 0.130 for cellulose in cuprammonium hydroxide
C = concentration in grams dry cellulose per 100 grams solution
η_{sp} = specific viscosity = $(\eta_{solution}/\eta_{solvent}) - 1$

Viscosity of the solvent was determined as 1.427 cp. The equation was solved graphically between the concentrations of 0.5 gram and 1.0 gram per 100 ml. of solution as shown in Fig. 3. From this plot the intrinsic viscosity was approximated and by substitution in Kramer's equation (*10*): D.P. = $K[\eta]$, where K = 260 for cellulose in cuprammonium hydroxide, the degree of polymerization was estimated.

The alpha-cellulose determinations were made according to the TAPPI standard method (*15, 17, 18*) using a 3-gram sample of linters, based on dry pulp, and 75 ml. of a 17.5% sodium hydroxide solution. Results were reported as per cent alpha-cellulose. Beta and gamma-cellulose were not determined.

Acetylation of the linters samples and tests on the acetate were conducted by the Waynesboro plant of E. I. du Pont de Nemours and Co., and consisted of the following:

1. Per cent acetic acid: determined by acid titration of a known quantity of sodium hydroxide present in excess. Reported as per cent combined acetic acid.

2. Viscosity: the viscosity in centipoises of a 24% solution of the cellulose acetate in acetone. Determined by the falling ball method.

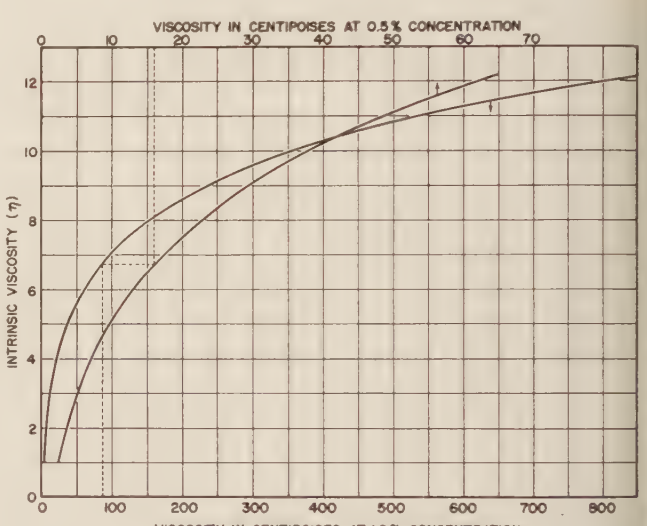

Fig. 3. Conversion of viscosities from 0.5 to 1.0% using Martin's Equation

3. Deposit: the number of 0.1 ml. of insoluble material that settles out of a 1.5% solution of the cellulose acetate in acetone in 24 hr.

4. Filterability: pounds of a 15% solution of cellulose acetate in acetone per square foot of filter area, that will pass through a specified filter pack under a pressure of 75 p.s.i.g.

5. Clarity: the depth in mm. of a 7% solution of the cellulose acetate in acetone, contained in a tube of specified diameter, at which a black dot 3 mm. in diameter just disappears.

6. Stability: the color of a sample of cellulose acetate dissolved in dimethyl phthalate and heated for 3 hr. at 200°C., as compared with a series of color standards. Reported as a stability standard number, equal numerically to the milliliters of a solution, containing 75 grams of $CoCl_2 \cdot 6H_2O$, 3 grams $K_2Cr_2O_7$, and 100 ml. of 40% H_2SO_4 in 1000 ml., which when made up to 100 ml. with distilled water most nearly matches the acetate solution.

RESULTS AND DISCUSSION

Extraction of Linters

As described in the operating procedure of the pilot plant extractor, the 50-lb. batches of linters were treated four separate times with hot isopropyl alcohol. Although the time involved to perform these extractions was much longer than in the case of the laboratory Soxhlet extractions, they would be equivalent to four cycles in the latter apparatus. These cycles occur about every 4 min. so by way of comparison the extraction time to perform the same amount of extraction in efficient equipment would be about 15 to 20 min. Kettering (*9*) shows that in properly run Soxhlet extractions, using isopropyl alcohol as the solvent, 83% of the wax is removed in 10 min. The amounts of material present in the linters extractable by isopropyl alcohol before and after the pilot plant extractions for two different batches were as follows:

Extract initially present, %	*Extract present after extraction, %*	*Recovery, %*
1.7	0.155	90.6
1.7	0.208	87.7

In both cases the residual extract is within the range usually found in the chemical cotton produced from raw cotton linters. Design of more efficient equipment would present no problem and complete removal of the alcohol extractable material is entirely feasible.

A marked change occurs in the wetting characteristics of the linters after extraction. When the dried extracted linters are brought in contact with water, the water is imbibed rapidly by capillary action and the linters sink beneath the surface. In contrast the raw linters having a wax coating which is hydrophobic will float indefinitely on the surface of water and only after 10 to 15 min. will they be wetted by hot caustic soda solution. Wetting agents, such as dodecyl alcohol salts and lauryl alcohol (*2*), are often used as digestion aids in the purification of linters. These help the solution to wet the fiber and result in more uniform pulping action; however, these agents do not of themselves remove the waxes and fats present. The noncellulosic part of the primary wall of the fiber is composed mainly of wax and fat, and pectic substance. These are intimately associated in the wall with an open cellulose structure and an impervious coat around the secondary wall composed of layers of cellulose. Before any substantial penetration of the caustic solution into the fiber can occur, the primary wall must either be removed or made permeable. This takes place when the fiber is solvent extracted. The pectic substance is largely unaffected; however, it is left with a greater exposed surface and is thus more susceptible to attack by the caustic solution in which it may be solubilized. Hoffman (*7*) has shown that the amount of wax in linters varies considerably. His values ranged from 0.73 to 2.0% and in one case to 4.9%. The waxes and fats probably comprise the greatest part of the noncellulosic matter in and on the fiber. In a charge of linters, such as is used in a commercial digester, the wax and fat content may vary appreciably. Extraction of the wax and fat has the obvious beneficial effect of reducing this variable to a constant low value and thus the linters will have more uniform pulping characteristics.

Observation of the linters during the course of digestion indicates another advantage gained by extraction. It was found that the hull matter disappeared at an earlier stage in the digestion process when the linters had been previously extracted. The hull matter is apparently more susceptible to attack by the caustic soda solution because the wax and fat associated with it are removed and the open structure remaining is subject to more rapid penetration of the digestant. This was substantiated in making the viscosity determinations on the samples observed. The cellulose solutions in cuprammonium hydroxide of the samples taken early in the digestion runs contained insoluble matter which from the shape and size was obviously hull matter. In comparable samples the extracted linters showed less insoluble matters and an earlier absence of insoluble matter in comparable series.

Digestion of the Linters

Digestion runs were made on the extracted and raw linters at five different temperatures: 250, 270, 300, 330, and 350°F. Caustic soda concentrations were varied from 1 to 3%. The ratio of caustic soda solution to linters was maintained at 10:1 for all runs. This, according to Hinner (5), is consistent with industrial practice and represents about the lowest ratio at which adequate mixing takes place. Duration of the runs was generally 6 hr., with samples being removed at hourly intervals. In Fig. 4 is shown a comparison of the viscosity reduction during digestion of different raw linters, A and B. The two samples were digested under identical conditions at a temperature of 300°F. and a caustic soda concentration of 3.0%. The greatest viscosity reduction occurred with linters A which had a

Table I. Alpha-Cellulose After Digestion of Raw Linters A

Digest conditions			*Alpha-cellulose, %*
Temperature, °F.	*Caustic concentration, %*	*Time, hr.*	
350	1.0	1	98.6
350	1.0	2	98.6
350	1.0	3	97.5
350	1.0	4	97.0
350	1.0	5	95.7
350	1.5	1	99.4
350	1.5	2	99.3
350	1.5	3	98.6
350	1.5	4	97.9
350	1.5	5	97.9
350	3.0	1	99.3
350	3.0	2	97.6
350	3.0	3	95.3
350	3.0	4	93.8
350	3.0	5	91.3
300	1.0	1	98.7
300	1.0	6	98.4
300	2.5	1	99.4
300	2.5	2	99.3
300	2.5	3	98.5
300	2.5	4	99.2
300	2.5	5	99.3
300	2.5	6	99.5
300	3.0	1	99.1
300	3.0	2	99.2
300	3.0	3	99.4
300	3.0	4	99.3
300	3.0	5	98.8
300	3.0	6	99.1

wax and fat content approximately one third less than linters B. The effect of caustic soda concentration on the viscosity of linters A is shown in Fig. 5 at two temperatures, 300 and 350°F. The data of Table I give the alpha-cellulose content of raw linters A digested at 300 and 350°F. for caustic soda concentrations of 1.0, 2.0, and 3.0%. It is seen that 1.0% caustic soda concentration was insufficient to give the maximum alpha-cellulose content, while at higher temperatures excessive time of digestion caused a rapid decrease in the alpha-cellulose content. At the higher temperature it is seen that the concentration of the caustic soda has a negligible effect on viscosity after digestion has proceeded for 2 hr.

The effect of temperature on the viscosities of raw and extracted linters is given in Fig. 6 and Table II. The concentration of caustic soda in these digestions was 3.0%. It is seen that extraction of the linters before digestion yields a product having a lower viscosity, or conversely, a product having the same viscosity can be produced in a shorter digestion period. At temperatures approaching 330°F. this effect becomes negligible, indicating that the wax and fat are removed rapidly by the caustic soda and penetration into the fiber is essentially the same for the raw and extracted linters. Table II gives the alpha-cellulose contents of the digested linters. No change is brought about by the extraction process. At 330°F. after 5 hr. of digestion the linters in both cases show a decrease in alpha-cellulose. Here the digestion conditions were too severe and the degradation of the cellulose has produced molecules of shorter chain length.

Table II. Properties of Digested Linters

Type linters	Digestion conditions: Temperature, °F.	Digestion conditions: Caustic concentration, %	Time, hr.	Viscosity, cp.: 0.5 g./100 ml. concentration	Viscosity, cp.: 1.0 g./100 ml. concentration	Intrinsic viscosity	Degree of polymerization
Raw	330	3.0	0.94	16.5	90	6.79	1800
Extracted	330	3.0	1.00	13.9	68	6.17	1600
Raw	330	3.0	1.63	9.90	38	5.00	1300
Extracted	330	3.0	1.77	8.36	28	4.46	1200
Raw	330	3.0	2.53	7.01	22	3.98	1000
Extracted	330	3.0	2.52	6.44	19	3.70	960
Raw	330	3.0	3.38	5.88	16	3.46	900
Extracted	330	3.0	3.38	4.89	12	2.92	760
Raw	330	3.0	4.05	5.22	13	3.10	810
Extracted	330	3.0	4.10	4.68	10	2.61	680
Raw	330	3.0	5.17	4.41	10	2.61	680
Extracted	330	3.0	5.05	4.03	9	2.46	640
Raw	300	3.0	0.75	42.8	437	10.44	2700
Extracted	300	3.0	0.76	35.0	311	9.62	2500
Raw	300	3.0	1.50	32.5	277	9.35	2400
Extracted	300	3.0	1.51	29.6	240	8.99	2300
Raw	300	3.0	2.25	26.2	194	8.48	2200
Extracted	300	3.0	2.26	23.2	157	8.02	2100
Raw	300	3.0	3.00	20.8	132	7.63	2000
Extracted	300	3.0	3.00	18.7	111	7.25	1900
Raw	300	3.0	4.02	17.7	102	7.05	1800
Extracted	300	3.0	4.10	14.5	73	6.36	1700
Raw	300	3.0	5.02	14.2	70	6.22	1600
Extracted	300	3.0	5.00	12.2	55	5.77	1500
Raw	270	3.0	1.00	56.8	695	11.60	3000
Extracted	270	3.0	1.00	48.8	546	11.00	2900
Raw	270	3.0	1.75	56.5	688	11.58	3000
Extracted	270	3.0	1.75	44.7	468	10.61	2800
Raw	270	3.0	2.50	49.5	556	11.04	2900
Extracted	270	3.0	2.50	40.5	395	10.20	2700
Raw	270	3.0	3.35	44.7	468	10.61	2800
Extracted	270	3.0	3.25	37.4	347	9.89	2600
Raw	270	3.0	4.18	40.4	392	10.19	2700
Extracted	270	3.0	4.00	35.0	311	9.62	2500
Raw	270	3.0	5.32	36.8	339	9.82	2600
Extracted	270	3.0	5.08	31.4	264	9.21	2400
Raw	250	3.0	0.75	61.5	795	11.91	3100
Extracted	250	3.0	1.00	61.9	803	11.95	3100
Raw	250	3.0	1.50				
Extracted	250	3.0	1.67	60.7	780	11.90	3100
Raw	250	3.0	2.25	58.9	739	11.75	3100
Extracted	250	3.0	2.33	60.1	766	11.82	3100
Raw	250	3.0	3.00	54.3	648	11.41	3000
Extracted	250	3.0	3.00	59.8	756	11.80	3100
Raw	250	3.0	4.00	51.0	583	11.18	2900
Extracted	250	3.0	4.00	51.5	592	11.20	2900
Raw	250	3.0	5.00	49.7	562	11.07	2900
Extracted	250	3.0	5.00	46.5	503	10.79	2800
Extracted	300	2.0	1.00	45.6	488	10.71	2800
Extracted	300	2.0	1.68	37.3	345	9.89	2600
Extracted	300	2.0	2.33	29.9	244	9.02	2300
Extracted	300	2.0	3.00	24.9	177	8.29	2200
Extracted	300	2.0	4.13	19.6	118	7.41	1900
Extracted	300	2.0	5.00	16.5	90	6.79	1800
Extracted	300	1.0	1.00	52.6	616	11.30	2900
Extracted	300	1.0	1.67	43.8	453	10.52	2700
Extracted	300	1.0	2.33	38.4	362	9.73	2500
Extracted	300	1.0	3.25	34.7	309	9.16	2400
Extracted	300	1.0	4.08	30.7	256	8.41	2200
Extracted	300	1.0	5.07	26.6	199	7.45	1900

Table III. Alpha-Cellulose After Digestion of Raw and Extracted Linters

Digestion conditions: Temperature, °F.	Digestion conditions: Caustic concentration, %	Digestion conditions: Time, hr.	Alpha-cellulose content, %: Raw	Alpha-cellulose content, %: Extracted
270	3.0	1	99.4	99.4
270	3.0	5	99.2	98.9
330	3.0	1	99.4	99.5
330	3.0	5	97.7	97.4

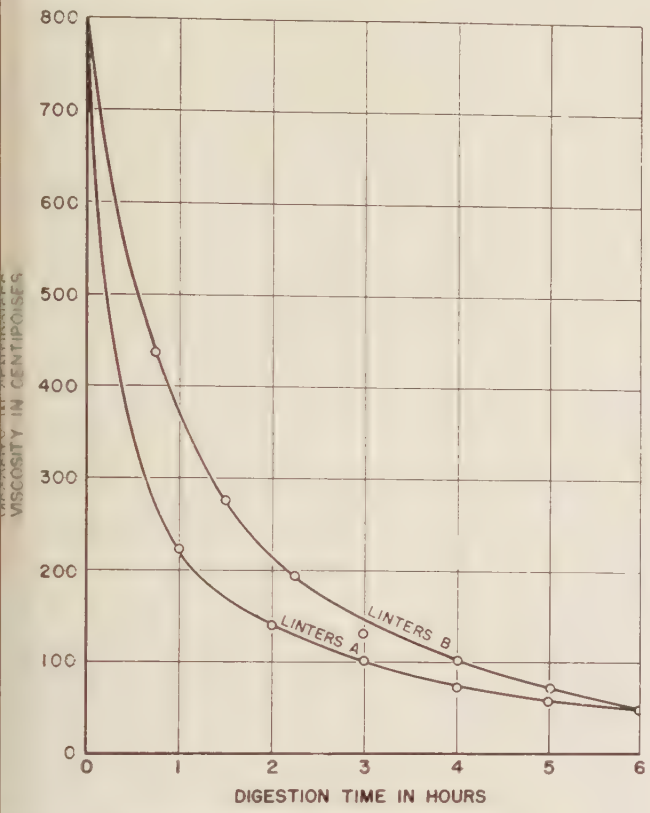

Fig. 4. Variation of viscosity of cellulose from raw linters of different source digested under identical conditions

The effect of caustic soda concentration on the viscosity of the cellulose produced at 300°F. is shown in Fig. 7. Increasing the concentration of caustic soda causes a greater viscosity reduction, while with increased digestion time the curves all approach the same value of viscosity.

A comparison of the curves given in Figs. 5 and 7 shows that the same effects are present whether the linters are dewaxed or raw. A further comparison of the curves in Fig. 4 with the curve for the dewaxed linters B in Fig. 6 will show that the viscosity of cellulose from linters A is generally lower than that from extracted linters B, particularly during the early stages of digestion. This indicates that other properties of the raw linters may affect the pulping characteristics in addition to the fat and wax content. In all probability, the degree of polymerization of the cellulose in the raw linters is an important consideration.

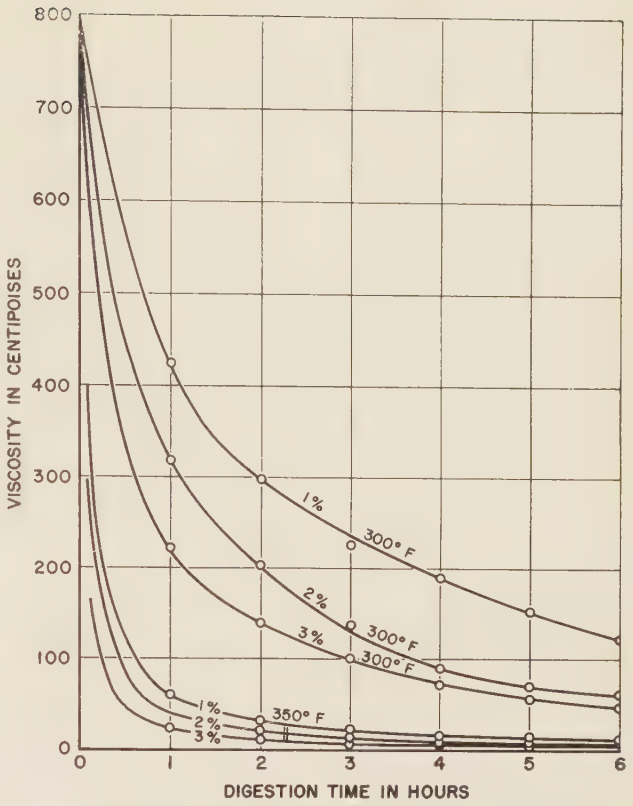

Fig. 5. Effect of caustic soda concentration on viscosity of cellulose at 300 and 350°F. for raw linters A

Acetylation of the Digested Linters

Three samples of extracted linters and three of the raw linters were digested under varying conditions and bleached under the same conditions of bleach consistency, temperature, available chlorine, and time. The samples were then acetylated to approximately the

Table IV. Acetylation of Digested Linters

	Sample number 1	2	3	4	5	6
Type linters	Extracted	Extracted	Extracted	Raw	Raw	Raw
Digestion temperature, °F.	300	300	270	300	300	270
Caustic concentration, %	3.0	1.0	1.0	3.0	1.0	1.0
Digestion time, hr.	2	1	2	2	1	2
Bleach consistency, %	3.0	3.0	3.0	3.0	3.0	3.0
Bleach temperature, °F.	86	86	86	86	86	86
Bleach time, hr.	2.5	2.5	2.5	2.5	2.5	2.5
Concentration available, Cl_2, based on linters, %	1.0	1.0	1.0	1.0	1.0	1.0
Cuprammonium viscosity at 1.0 g./100 ml. concentration, cp.	95	450	511	91	503	550
Alpha-cellulose, %	99.4	99.6	99.3	98.9	99.5	99.1
% HOAC	54.75	55.60	55.70	54.55	55.05	54.95
24% Solution viscosity, cp.	525	515	570	610	625	690
Deposit	10.0	40.0	5.0	8.0	50.0	25.0
Clarity	50	50	50	50	50	40
Filterability	3.0	2.8	2.6	2.7	1.4	1.3
Stability	6	5	5	5	5	8

same combined acetic acid content, and the tests previously described performed on the acetate. The data from these tests and the conditions of digestion and bleaching are shown in Table IV. Defining activity as the ease and uniformity with which the acetylation reaction proceeds, the order of decreasing activity of the six samples was found to be 1, 2, 3, 4, 5, 6. Thus, higher digestion temperature and caustic soda concentration caused an increase in activity, but the samples of extracted linters all showed greater activity than the raw samples. From Table IV the data on the other tests show at a digestion temperature of 273°F. that the extracted material retains the same clarity and stability as the samples digested at 300°F. while the raw material exhibits a loss in these properties. The filterability is increased in all cases by extraction.

CONCLUSIONS

1. Solvent extraction of cotton linters before digestion makes possible the recovery of the cotton wax as a by-product.
2. The extracted linters enter the digestion process with a constant low wax and fat content thereby eliminating a troublesome variable.
3. The extracted linters are highly absorbent and penetration of the digestant into the fiber occurs at an increased rate. Use of digesting aids such as wetting agents is not required.
4. Digestion of the linters takes place more rapidly if the linters are previously extracted. Since impurity solubilization is enhanced, the digestion of extracted linters can be carried out under conditions of lower caustic soda concentration and digestion time to achieve the same degree of purification and viscosity.

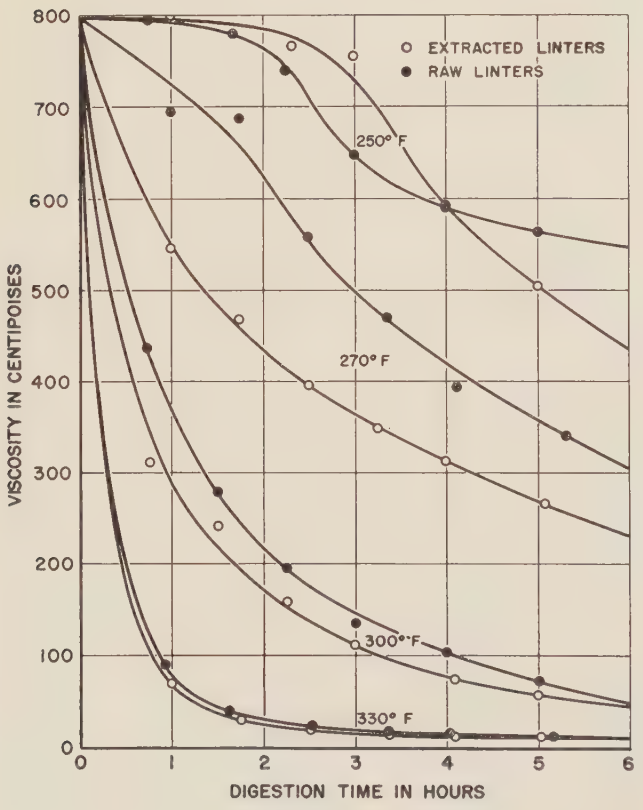

Fig. 6. Effect of temperature of digestion on viscosity of cellulose from dewaxed linters (caustic soda concentration 3.0%)

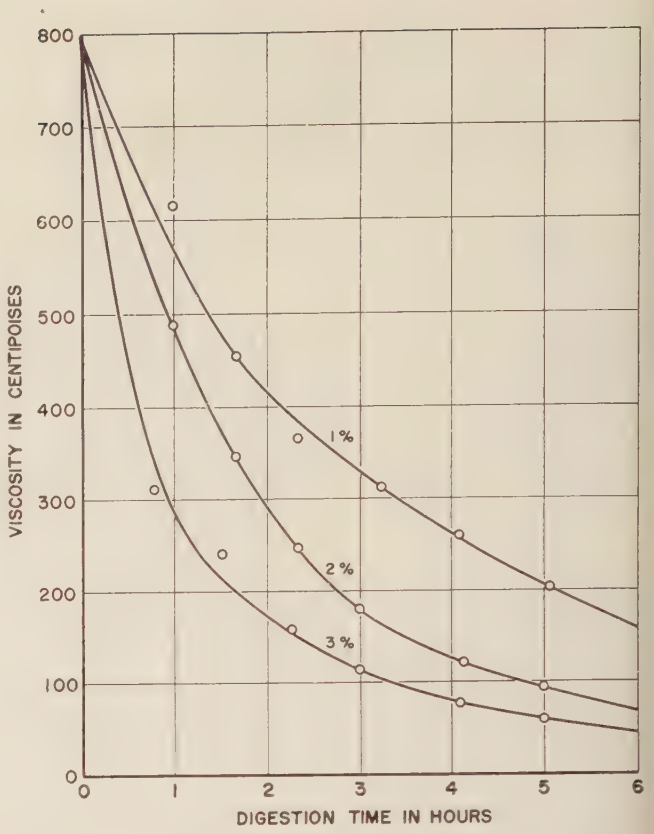

Fig. 7. Effect of caustic soda on the viscosity of dewaxed cotton linters digested at 300°F.

5. Because impurity solubilization is enhanced, a lower temperature can be employed for digestion of the extracted linters and the same degree of purification attained as in the case of raw linters digested at a higher temperature, but with less degradation of the cellulose and consequently with less viscosity reduction.

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Sulphur Usage and Distribution in Sulphite Pulping

C. H. ANDERSON

Sulphur balances were made on calcium bisulphite western hemlock experimental cooks. Sulphur consumption and distribution were computed and their relation to pulp yield illustrated graphically. Sulphur consumption, defined as total sulphur in spent cooking liquor flashed at 5 p.s.i. plus sulphur left in the digester after draining the spent liquor, plus sulphur unaccounted for, decreased from about 265 to 170 lb. per air-dry ton of screened pulp as yield was increased from 40 to 50%. Stripping of flashed spent liquor showed potential additional savings of only 10 to 20 lb. of sulphur per ton which probably would not justify the operation. Recycling of relief liquor solids had little or no effect on sulphur usage or distribution. In the range 140 to 148°C., cooking temperature had no appreciable effect on sulphur usage but altered the distribution of recovered SO_2 between gas relief and gases flashed from spent liquor. The sulphur usages presented here could be considered limiting values which might be realized commercially if suitable equipment and procedures were employed.

ALTHOUGH the critical sulphur shortage which occurred recently has now been eased by the introduction of new productive capacity and by the conservation measures forced upon users during the shortage, data on the basic requirements for sulphite pulping will always be of fundamental importance to the sulphite pulping industry.

The literature contains many references to sulphur usages prevailing at individual mills and these references clearly demonstrate the fact that sulphur usage per ton of pulp is increased by cooking softer, lower yield pulps and the increase is greater than can be accounted for by differences in yield. Unfortunately, however, equipment and procedures differ from mill to mill which makes it impossible to relate these reported sulphur usages with yield in any quantitative manner.

Aside from over-all sulphur usage, it would often be desirable to know the distribution of recoverable and nonrecoverable sulphur among the various process streams when operating under a well-defined set of conditions chosen to promote the highest practical recovery of sulphite sulphur and, hence, minimum sulphur consumption.

Comparison of actual mill data with these more idealized results would show the total potential sulphur savings which could be gained either by simulating the experimental conditions on a large scale or by operating under other conditions which would result in equivalent over-all losses to the atmosphere and sewer.

It was the purpose of this work to obtain these consumption and distribution data by operation of a pilot scale digester on an experimental basis, carefully measuring the sulphur input in the cooking acid and the sulphur output in all effluent streams. The pulping experiments were performed with western hemlock chips using calcium bisulphite cooking liquor containing 5% free SO_2 and 1% combined SO_2. The temperature and length of cook were controlled to give unbleached pulp yields in the range of 40 to 50%. Two types of cooking liquor were employed, one being organics-free, the other containing the liquid relief from a previous cook. The latter procedure corresponds more closely to mill practice.

The data for the preparation of sulphur balances were obtained by collecting, measuring, and sampling all discharged effluents. Particular care was exercised to avoid equipment leakage or loss of any material containing sulphur. Sulphur input was measured as the SO_2 or sulphur content of the fresh acid and relief liquor charged. Output was measured as the sulphur content of (1) liquid relief, (2) gaseous relief, (3) flashed spent cooking liquor, (4) gas flashed from spent liquor, (5) wash water, and (6) unscreened pulp.

The results were expressed as pounds of sulphur per ton of air-dry screened pulp.

EXPERIMENTAL

Western hemlock chips used in these experiments were obtained from a mill chipping plant. Cooks were carried out in an 8 cu. ft. stainless steel digester equipped for acid circulation through an external heater. Cooking acid was prepared from U.S.P. calcium hydroxide and cylinder sulphur dioxide. All acids were adjusted initially to contain 5.0 to 5.1 grams per 100 ml. free SO_2 and 0.99 to 1.01 grams per 100 ml. combined SO_2. For those acids containing recycled relief, the amounts of fresh calcium hydroxide and sulphur dioxide were adjusted to give the foregoing composition as determined by analysis.

The pilot plant digester used for these experiments was provided with a recovery system illustrated diagrammatically in Fig. 1.

This system provided means for separate recovery of liquid and gas relief during the course of the cook and at completion of the cook permitted flashing of the spent sulphite liquor at digester pressure to 5 to 6 p.s.i. in an external vessel. The flashed SO_2 was determined by absorption in a caustic solution.

Cooks were carried out under the following conditions:

Total liquid: wood ratio, kg. per kg. moisture-free	5.9
Combined SO_2: wood ratio, kg. per 100 kg. moisture-free.	4.8
Maximum pressure, p.s.i.g.	110
Maximum temperature, °C.	145
Time to maximum temperature, hr.	5.0

Cooking time at maximum temperature was varied to produce a range of yield from 40 to 50%. To show the effect of cooking temperature, additional cooks at the lowest and highest yield levels were made at 148 and 140°C., respectively. These temperatures resulted in

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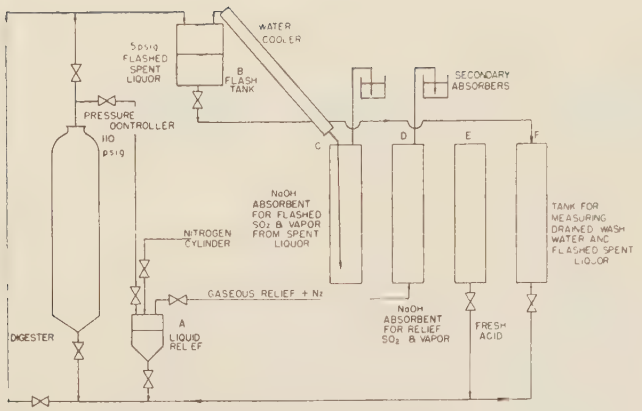

Fig. 1. Experimental digester with relief and liquor systems for collecting sulphur-balance data. (Tanks C, D, E, and F are provided with cooling showers and stirrers. Blow pit is not shown)

approximately similar cooking times at the various yield levels.

In carrying out the cooks, the digester was charged with 33 kg. moisture-free chips and a small quantity of water was added to compensate for variations in the moisture content of the chips. The quantity of cooking acid to give the specified liquid:wood ratio (5.9) was then pumped into the digester. The SO_2 lost by venting during the final stages of filling was determined by scrubbing the displaced air in caustic solution. The charge of acid and chips was such as to give a starting pressure of about 25 p.s.i.g. before steaming.

The digester was steamed through an external heater and no relief was permitted until the specified maximum pressure (110 p.s.i.g.) was reached after about 2 hr. steaming. Pressure was automatically held at 110 p.s.i.g. with the liquid relief being trapped in the small tank A (Fig. 1). The bulk of the SO_2 gas in the relief passed through tank A and was absorbed in a caustic solution (50 grams NaOH per liter) in tank D. When the rate of evolution of the relief gases subsided as maximum temperature was reached, nitrogen was introduced into tank A, maintaining a positive flow through D to prevent caustic being drawn back into A.

When it was estimated from liquor color that the desired degree of cooking had been reached, the spent cooking acid was drained at full digester pressure to the flash tank B which had been previously flushed with steam to displace air. The rate of draining was adjusted so that the pressure in flash vessel B did not exceed 5 to 6 p.s.i.g. The drain line connecting the digester and the flash vessel remained open after all liquid had been drained (at about 80 p.s.i.g.) and was not closed until the pressure on the system had fallen to about 2 p.s.i.g. (about 10 min.). The SO_2 and steam flashed in vessel B were cooled by a water condenser and absorbed in a caustic solution in tank C. To confirm completeness of absorption the overgas from each of the vessels C and D was passed through a small secondary absorber containing caustic. The absorption of the SO_2 in the primary tanks was quantitative since in no case was appreciable SO_2 found in the secondary absorbers.

At about 2 lb. residual pressure, the drain valve was closed and the digester top relief was connected with the flash vessel B. The digester was filled with cold water which was circulated for 15 min. before sampling and draining. This washing process was repeated three times and a properly proportionated composite sample of the total wash water was prepared. After sampling and measuring, the final wash water was returned to the digester, circulated and steamed to 100°C. in about 20 min. The cooked chips were then blown into the blowpit with the aid of compressed air. A small sample of the unwashed, blown pulp was saved for analysis and the balance was washed and screened for yield determination.

The flashed spent liquor in vessel B was transferred to F while still hot for cooling and measuring. The quantity of liquor removed from the digester for color sampling was noted.

To demonstrate the amount of SO_2 which might be recovered from the spent sulphite liquor by additional stripping, the following procedure was carried out on each flashed, spent liquor. A 100-ml. portion of liquor was heated to boiling in a distilling flask equipped with condenser and bubbler containing caustic solution. When about 6 ml. of distillate had been collected, heating was discontinued and the system was flushed slowly with nitrogen to displace SO_2 in the vapor space. The stripping action was stopped by immersing the flask in cold water coincident with starting the nitrogen flushing step.

The amount of SO_2 stripped was determined iodimetrically by direct titration of the caustic solution in the bubbler and also by determining the difference in total sulphur content of the spent liquor sample before and after stripping.

The free and combined SO_2 contents of the organics-free cooking acids were determined by the Palmrose

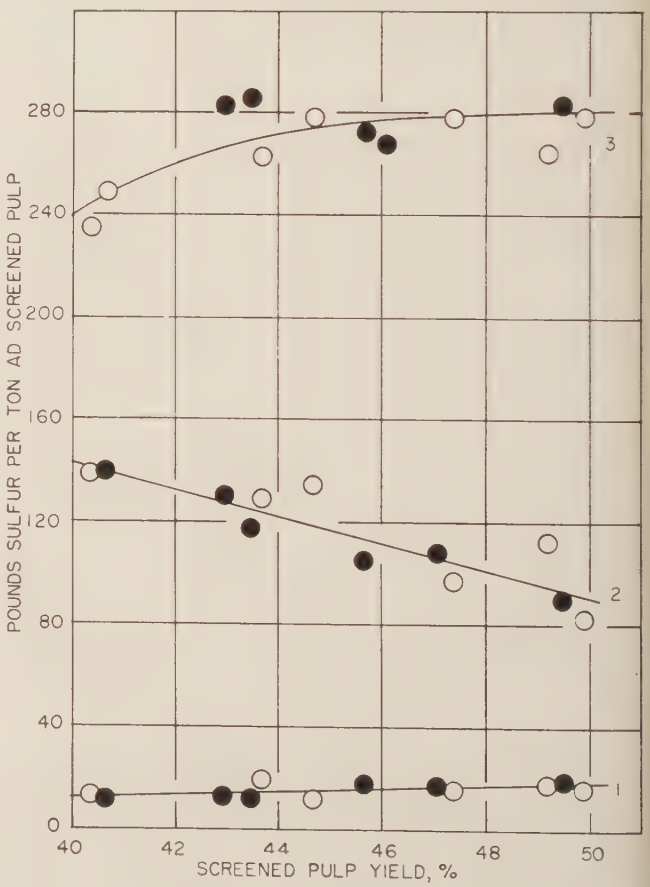

Fig. 2. Distribution of recoverable sulphur at different yield levels

1, SO_2 stripped from spent liquor; 2, SO_2 in liquid and gaseous relief; 3, SO_2 flashed from drained spent liquor.

method (*1*). Relief liquors were tested for free and combined SO_2 by a modification of this method in which, for better end-point determination, the titration for free SO_2 is made by adding excess iodate and back titrating with thiosulphate. Total sulphur was determined in all liquors containing organic solids by the nitric-perchloric acid method of Yorston (*2*). Liquors containing appreciable free SO_2 were first titrated with potassium iodate to the starch point to preclude the loss of free SO_2 during the initial steps of the nitric-perchloric acid oxidation. SO_2 absorption in caustic solutions was determined by acidified iodine and back titration with sodium thiosulphate.

Since some possibility existed that reducing agents other than sulphite sulphur might be included in the latter determination, the alkaline absorbent solutions were analyzed also for sulphide and thiosulphate by direct iodimetric titration of samples blocked with formaldehyde at pH 4 and for total sulphur by nitric-perchloric acid oxidation. The iodimetric determinations showed the absence of sulphide and thiosulphate in these solutions, and the total sulphur found by oxidation was equivalent to the sulphite sulphur determined iodimetrically. Under the acidic conditions (pH about 4) of the iodimetric determinations used, sulphite sulphur in combination with low molecular weight aldehydes would not be expected to reduce iodine. Hence the results indicate the presence of negligible amount of bisulphite addition products in the relieved, flashed, and stripped gases.

The possibility of loss of sulphur through formation of sulphate during the preparation of cooking acid was examined and found to be of no consequence.

RESULTS

The analytical and flow data obtained in these experiments are summarized in Table I. The sulphur distribution among the process streams, calculated from the data in Table I and expressed as pounds of sulphur per air-dry ton of screened pulp, is shown in Table II. A graphic presentation of these data showing more clearly the relationship between the digester

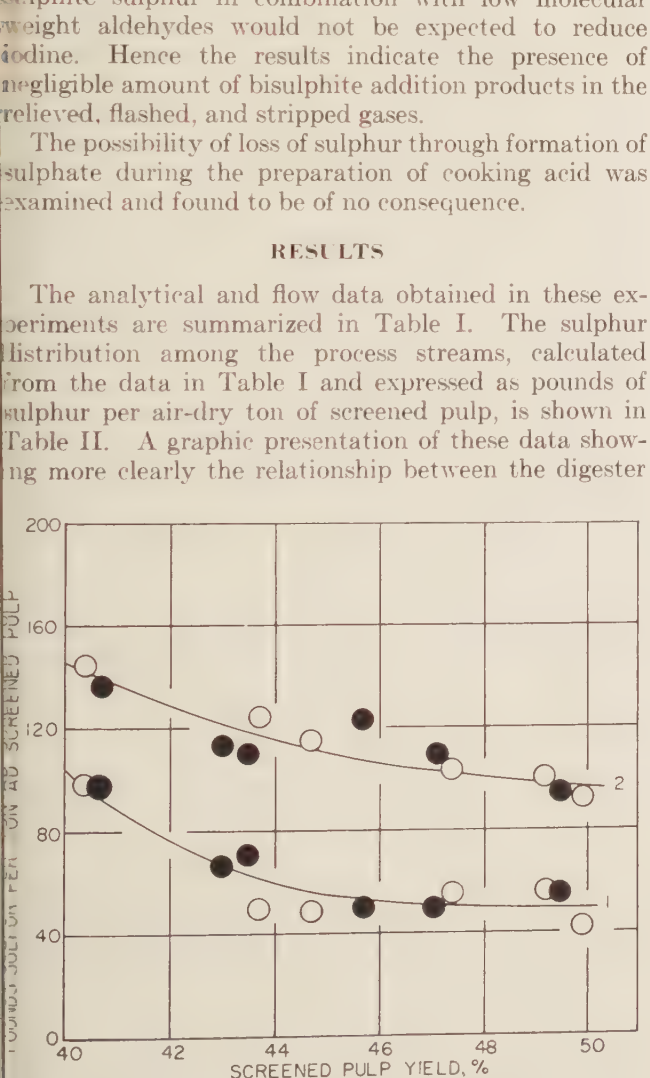

Fig. 3. Distribution of nonrecoverable sulphur at different yield levels
1, sulphur remaining in digester after draining; 2, sulphur in flashed spent liquor.

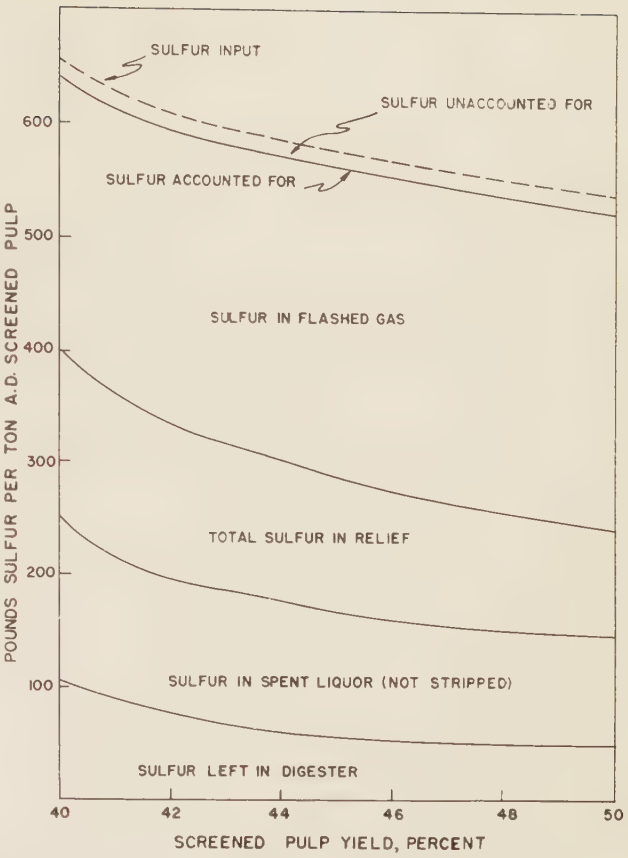

Fig. 4. Over-all sulphur distribution among process streams

streams for cooks made at 145°C. is seen in Figs. 2 and 3. In these and subsequent plots, shaded and open circles represent data on cooks with and without recycled relief, respectively. In Fig. 2, curve 2, representing the SO_2 in total relief, is derived from the sum of lines H and I in Table II. In Fig. 3, curve 1, showing sulphur remaining in the digester after draining the spent liquor, is the sum of lines F and G in Table II. Curve 2 in Fig. 3, the sulphur in spent liquor, is the sum of lines E and K in Table II.

To illustrate the over-all relationship of the individual sulphur distributions shown in Figs. 2 and 3, they have been plotted as cumulative curves in Fig. 4. The small area between the dotted line and solid line at the top of the figure represents the average unaccounted for sulphur.

As shown in Table III, changing the cooking temperature had little effect on the total recoverable sulphur but did alter the distribution between the relieved and flashed gas streams. The increased temperature in the low yield cook caused more SO_2 to be relieved during the cook, leaving less to be flashed at the end. The lower temperature in the high yield cook had the opposite effect.

Sulphur "usage" or "consumption" which is the difference between the total input sulphite sulphur and the total recovered sulphite sulphur may also be defined as the sum of the nonsulphite sulphur in the relief, the total sulphur in flashed or stripped spent liquor, the total sulphur in the washings, the total sulphur in the pulp, and sulphur unaccounted for, less the nonsulphite sulphur in recycled relief (Table II). Sulphur usages when spent liquors were flashed but not stripped ranged from about 265 to 170 lb. per air-dry ton as yield was

Table I. Sulphur Analyses and Flow Data on Sulphite Process Streams

Cook Number →	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
Weight of moisture-free wood, kg. →	*33.5*	*33.0*	*33.5*	*33.5*	*33.1*	*33.0*	*33.0*	*33.5*	*33.5*	*33.0*	*33.1*	*33.0*	*33.5*	*33.0*	*33.0*	*33.5*
Cooking acid																
Combined SO_2, g. S/l.	5.0	5.0	5.0	5.0	5.0	5.25	5.1	5.0	5.0	5.2	5.2	5.2	5.0	5.0	5.2	5.0
Free SO_2, g. S/l.	25.5	25.0	25.1	26.2	25.0	26.5	25.0	25.1	24.9	26.0	25.3	26.4	24.8	25.1	25.9	25.0
Non-SO_2-S from relief, g. S/l.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.25	0.37	0.35	0.24	0.26	0.27	0.35	0.28
Volume acid pumped, l.	161	158.5	161	160	161	151	155	161	161	154	155	151	162	158.5	154	161
Liquid relief																
Total SO_2 (iodim.), g. S/l. (A)	11.0	14.0	12.6	10.8[a]	11.4	11.6	10.95	20 0	10.4	10.55	12.5	9.2	11.6	12.8	11.75	13.1
Total S (oxid.), g. S/l. (B)	13.1	16.2	13.7	13.0	13.7	14.1	13.0	22.0	12.5	12.9	14.9	11.5	13.7	15.1	13.9	15.3
Non-SO_2 (=B−A), g. S/l.	2.1	2.2	1.1	2.2[a]	2.3	2.5	2.05	2.0	2.1	2.35	2.4	2.3	2.1	2.3	2.15	2.2
Volume, l.	18.7	17.5	17.1	16.5	20.6	22.6	21.75	19.7	19.6	22.2	21.7	21.0	17.5	18.9	22.0	19.6
Gas relief																
Total SO_2 (iodim.), g. S/l.	6.49	4.00	4.12	4.71	3.08	3.84	2.64	0.84	6.28	4.24	3.80	3.76	3.42	3.48	2.80	1.45
Volume of solution (final), l.	191	196.5	200.5	199	197.5	194.5	193	199.5	192	191	200	197.5	200.5	198	198.5	196
Flashed spent liquor																
Total S (oxid.), g. S/l.	10.0	10.2	8.4	8.5	8.2	8.4	7.9	8.4	10.2	10.1	8.6	8.9	8.8	8.4	8.2	8.3
Total SO_2 (iodim.), g. S/l.	0.03	...	0.11	...	...	...	...	0.32	...	...	...	...	0.15	...	...	...
Volume, l.	110.5	106.5	118	114	109.5	108	105	113.5	110	99	103	98.7	119.5	112	104	112
pH	1.2	...	1.6	2.0	1.9	2.2	2.2	2.0	1.1	1.3	1.8	1.1	1.8	1.9	2.3	2.0
Flashed gas																
Total SO_2 (iodim.), g. S/l.	7.08	8.12	10.02	10.91	11.10	10.79	11.83	12.37	7.04	8.40	10.00	10.27	10.75	10.31	11.48	12.92
Volume of solution (final), l.	218	215	213.5	212	218	221	222.5	218	214.5	221.5	223	221	215	224	224	209
Stripped spent liquor (adjusted to initial volume)																
Total S (oxid.), g. S/l.	9.2	9.3	7.1	7.6	6.9	6.9	6.5	6.7	9.3	9.4	7.7	7.9	7.5	7.1	6.5	6.7
SO_2 stripped (iodim.), g. S/l.	0.8	0.8	1.2	0.9	1.2	1.4	1.4	1.7	0.7	0.9	1.0	1.0	1.3	1.2	1.6	1.5
Washings																
Total S (oxid.), g. S/l.	1.30	1.46	0.79	0.79	0.96	1.01	0.75	0.84	1.57	1.65	1.2	1.29	0.81	0.86	1.05	0.83
Volume, l.	470	475	474	469	463	428	389	444	488	396	395	414	483	458	385	448
Pulp																
Total S (oxid.), %	0.14	0.27	0.22[a]	0.22[a]	0.24	0.43	0.45[a]	0.45	0.24	0.22[a]	0.22[a]	0.21	0.22	0.22	0.45[a]	0.46
Weight, moisture-free unscreened, kg.	13.9	13.4	14.8	15.2	15.8	16.4	16.7	16.8	13.8	13.5	14.3	14.4	15.5	15.6	16.55	16.8
Weight, moisture-free screened, kg.	13.7	13.35	14.6	15.0	15.7	16.2	16.5	16.35	13.6	13.4	14.2	14.3	15.35[a]	15.5	16.3	16.2

[a] Estimated values.

increased from 40 to 50%. Recycling relief solids had no consistent effect on sulphur usage. These results are shown in Fig. 5.

In the sulphur balances of Table II, the sulphur accounted for is generally slightly less than the input. The average of these experimental losses is 15 lb. of sulphur per ton of pulp from an average input of 580 lb. per ton. The possibility that part of this loss may be attributable to the formation of some nonreducing sulphur compounds including bisulphite addition products in the gas-caustic absorption system has been eliminated by the agreement between total sulphur and sulphite sulphur determinations on these solutions. The other possibility, the inadvertent loss of SO_2 during the cooking and recovery operations might justify the exclusion of the unaccounted for sulphur from the usage figures which would result in the curve in Fig. 6. The sulphur consumption would then range from 260 to 150 lb. per ton. Exclusion of the unaccounted for sulphur smoothed out the consumption curve pulling all the data into closer alignment.

It has been estimated roughly that the additional sulphur recovery of 10 to 20 lb. per ton that could be realized by stripping SO_2 from the spent liquor (curve 3, Fig. 2) would require heat equivalent to 700 to 1000 lb. of steam per ton of pulp. Commercially, a stripping step would seem warranted only if this steam usage could be materially reduced. If such a stripping step were practiced the sulphur usage would range from about 255 to 150 lb. per air-dry ton of pulp and the curve would be similar to Fig. 5.

As shown in Table III, cooking temperature over the range 140 to 148°C. has little or no effect on sulphur usage assuming an efficient recovery system.

Table II. Sulphur Distribution in the Sulphite Pulping Process

Sulphur in Pounds per Air-dry Ton Unbleached Pulp

Cook number →	*Organics-free cooks*						*Recycled relief cooks*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
Yield, screened, %	40.9	40.4	43.7	44.7	47.4	49.2	49.9	48.7	40.7	40.7	43.0	43.5	45.7	47.1	49.5	48.4
TAPPI viscosity, 1% cuam, csp. (T206)	12	15	77	83	100	200	145	210	12	17	60	42	90	100	180	220
TAPPI "K" number	5.7	4.1	10.8	11.4	10.6	18.7	35.0	24.0	6.3	5.3	9.8	5.5	13.5	10.6	32.8	23.5
Max. temp., °C.	148	145	145	145	145	145	145	141	148	145	145	145	145	145	145	140
Cooking time, hr.: min.	6:14	7:31	5:40	5:36	5:36	5:04	4:47	5:47	6:12	7:14	6:06	6:21	5:44	5:40	4:50	5:53
Sulphur Balance																
Sulphur input																
A. Nonsulphite sulphur from relief	0	0	0	0	0	0	0	0	5	8	7	5	5	5	6	5
B. SO_2 from relief and raw acid	643	641	596	600	553	531	522	535	635	640	597	598	566	552	525	536
C. Total sulphur input	643	641	596	600	553	531	522	535	640	648	604	603	571	557	531	541
Sulphur output																
D. Nonsulphite sulphur in relief	5	5	4	4	5	6	5	4	5	7	7	6	4	5	5	5
E. Total sulphur in stripped liquor	135	132	104	103	87	82	75	84	136	125	100	98	105	92	75	84
F. Total sulphur in washings	80	94	46	45	51	48	34	41	100	93	63	67	46	46	47	41
G. Total sulphur in pulp	3	5	4	4	4	8	8	8	4	4	4	4	4	4	8	8
H. SO_2 in relief gas	163	106	102	112	70	83	56	18	159	109	96	93	81	80	61	32
I. Sulphite sulphur in liquid relief	27	33	27	22	27	29	26	44	27	31	34	24	24	28	29	29
J. SO_2 flashed from drained liquor	203	235	263	278	278	264	278	297	199	249	282	285	272	268	283	300
K. SO_2 stripped from flashed drained liquor	12	13	20	12	16	18	17	21	10	12	13	12	18	17	19	20
L. Total sulphur output	628	623	570	580	538	538	499	517	640	630	599	589	554	540	527	519
M. Sulphur unaccounted for	15	18	26	20	15	−7	23	18	0	18	5	14	17	17	4	22
Sulphur Recovery and Usage																
N. Sulphite sulphur in liquid and gas relief (H + I)	190	139	129	134	97	112	82	62	186	140	130	117	105	108	90	61
Total sulphur recoverable as SO_2																
O. Without stripping (J + N)	393	374	392	412	375	376	360	359	385	389	412	402	377	376	373	361
P. With stripping (J + K + N)	405	387	412	424	391	394	377	380	395	401	425	414	395	394	392	381
Sulphur consumption																
Without stripping (B − O)	250	267	204	188	178	155	162	176	250	251	185	196	189	176	152	155
With stripping (B − P)	238	254	184	176	162	137	145	155	240	239	172	184	171	159	133	155

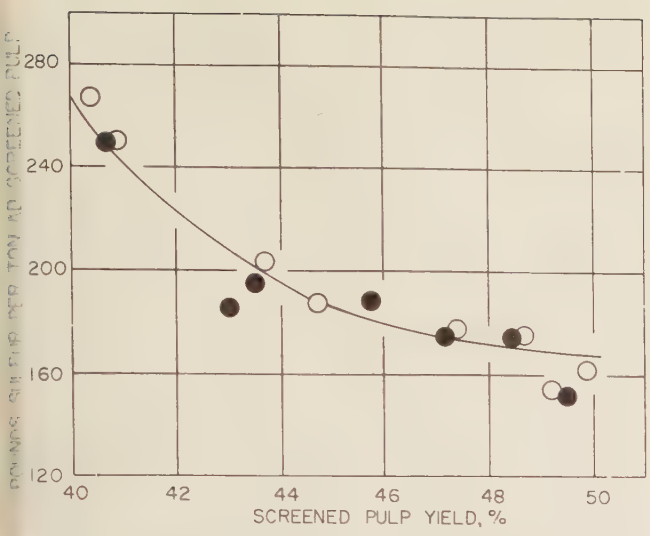

Fig. 5. Sulphur consumption with varying pulp yield when spent liquor is not stripped

DISCUSSION

In certain respects, these experiments were made under conditions corresponding closely to mill operations, while in others, the conditions were altered to facilitate measurement.

Liquid:wood ratio and initial charging pressure were similar to those in mill practice, and maximum digester pressure, after allowance for hydrostatic head, was about normal. Hence it could be assumed that the relief procedure was representative of mill operation.

Rather than the usual mill procedure of "blowing down" to 20 to 40 p.s.i.g. to recover SO_2 at the end of the cook, flashing of the spent liquor to 5 p.s.i.g. in an external vessel was adopted because it furnished a more readily defined stripping action which was less affected by those variables which are responsible for mill-to-mill differences in sulphur recovery at this point. The amount of SO_2 evolved by this procedure would be greater than the amount usually recovered by digester blowdown, the difference being about the amount that could be recovered by effective absorption of blowpit gases if no cooling water was used in the blowpit.

The use of water to wash the unblown chips in the digester after liquor draining was a laboratory expedient to recover sulphur. In a mill employing liquor flashing the cooked chips would probably be sluiced out with flashed spent liquor or stripped spent liquor. The sulphur in the wash water plus sulphur in the unscreened pulp represent the amount of sulphur remaining in the digester after venting to 2 p.s.i. This quantity was not considered recoverable although it contains some SO_2.

The sulphur consumption values reported in the literature vary over a wide range. As previously mentioned, this variation is largely the result of differences in mill equipment and procedures and, to a lesser extent, to differences in type of pulp manufactured. In 1936 Davies (*3*) reported that usages in Canada ranged from 200 to 400 lb. per air-dry ton. He demonstrated that in an ordinary sulphite mill with the usual equipment and operating control, sulphur usages could be reduced to just under 200 lb. per ton by merely prolonging the gassing-off period at the end of the cook. He considered that the "theoretical" minimum usage of 170 lb. per ton previously proposed by Edwardes (*4*) was a reasonably good value. Actually Davies' prolonged blowdown would not be expected to release SO_2 as completely as would, for example, a flashing step at 5 p.s.i.g.

Recently the Waste Committee of the Technical Section of the Canadian Pulp and Paper Association published the results of a survey of sulphur usages at eight Canadian mills (*5*). This survey showed a range in total usage from 200 to 255 lb. per ton (236 lb., average) but data on extent of cooking are lacking. For these mills, the typical blowpit stack loss was 25 to 30 lb. per ton and acid tower loss 5 to 6 lb. The difference between the total usage and sum of blowpit stack plus acid tower loss was designated loss "in waste liquor" but this item would, in fact, also have included all other losses.

Since acid tower loss is not a part of sulphur input to the digesters and blowpit stack loss should be largely potentially recoverable as SO_2 and therefore not consumed in a chemical sense, it can be concluded that the over-all sulphur usage reported by these mills would not be far from 200 lb. per ton if they were able to practice a more complete blowdown at the end of the cook.

In contrast to these actually experienced usages, theoretical consumptions have been arrived at by Rapson and Wayman (*6*) by summing up the amounts of sulphur tied up in lignosulphonic acid, bisulphite addition products with aldehydes, thiosulphate, sulphate, and organic sulphides. By using published data supplemented by their own experimental results, they arrived at the following amounts of sulphur which would not be recoverable as SO_2:

175 lb. sulphur per air-dry ton at 42% yield
160 lb. sulphur per air-dry ton at 46% yield

The sulphur requirements arrived at under our conditions are intermediate between the theoretical values of Rapson and Wayman and those actually experi-

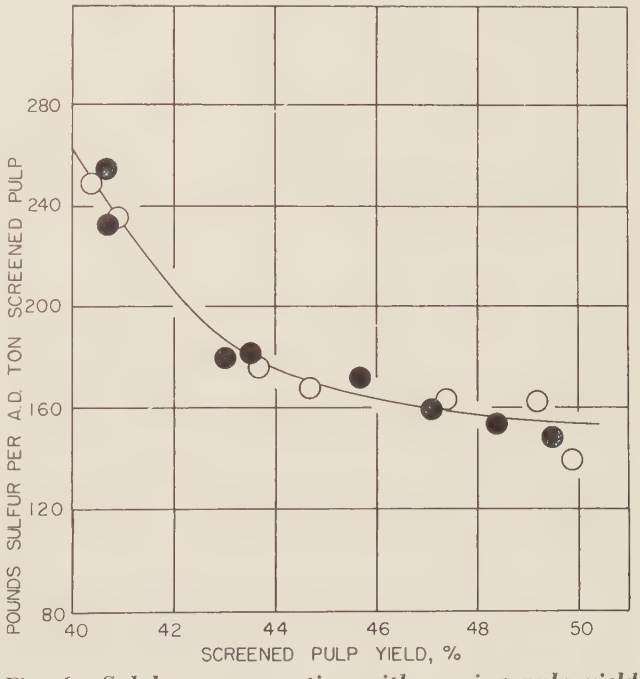

Fig. 6. Sulphur consumption with varying pulp yield excluding unaccounted- for sulphur (spent liquor not stripped)

Table III. Effect of Cooking Temperature on Sulphur Distribution and Consumption

Sulphur values in pounds per air-dry ton

Unbleached yield, % →	48.6		40.8	
Cooking temp., °C. →	140	145[a]	145[a]	148
SO_2 in relief	62	98	140	188
SO_2 in flashed gas	300	280	248	201
Total	362	378	388	389
Sulphur consumed				
Without stripping	175	171	248	250
With stripping	155	154	232	239

[a] Sulphur values for 145°C. cooks taken from curves of Figs. 2, 3, 4, and 5

enced by the Canadian mills. This is as it should be since counting any SO_2 sulphur left in the digester after draining liquor plus any remaining in spent liquor after stripping as lost would result in higher than theoretical consumption, and flashing at 5 p.s.i.g. would result in lower consumption than prevails under usual mill conditions.

Although the effect of variations in combined and free SO_2 content of cooking acids has not been examined in these experiments, it is reasonable to assume that the amount of sulphur unrecoverable after cooking to a given yield will increase with increasing combined, since the additional base would combine with more SO_2. On the other hand, increasing free SO_2 concentration would be expected to have little or no effect on the net sulphur consumption.

An empirical equation relating sulphur consumption to liquor:pulp ratio and total SO_2 and combined SO_2 in cooking acid has been developed by Kopantsev (7). However, this relationship is not general and at best could hold true under only a limited set of conditions where relief and blowdown procedures were closely prescribed.

SUMMARY

Pilot-scale pulping experiments were performed with hemlock chips and calcium bisulphite cooking liquor, using selected cooking schedules to produce a range of pulp yield from 40 to 50%. Sulphur input to and output from the digester were measured. Distribution of sulphur among the discharged streams was computed as pounds per air-dry ton of pulp. Maximum cooking temperature over the range 140 to 148°C. was demonstrated to affect principally the relative amounts of SO_2 flashed through relief and flashed from the spent liquor.

Sulphur consumption was computed and its relationship to unbleached pulp yield was shown graphically. Consumption decreased from about 265 to 170 lb. of sulphur per air-dry ton of screened pulp as yield increased from 40 to 50% when liquor was flashed at 5 p.s.i.g. but not stripped.

Recycling of relief solids in the cooking acid and varying maximum cooking temperature from 140 to 148°C. had little or no effect on net sulphur consumption.

Furthur sulphur savings of 10 to 20 lb. per ton could be made by stripping the flashed spent cooking liquor but steam requirements would be high.

The sulphur usages arrived at in this work can be considered more or less limiting values which, however, could be realized commercially if suitable equipment and procedures were employed. Provided that allowance is made for differences such as wood species and combined SO_2 in cooking acid, an estimation of potential sulphur saving possible by changing procedures and equipment at a given mill can be made by comparison of actual mill usage with that reported in this paper.

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Deterioration Losses in Stored Southern Pine Pulpwood

RALPH M. LINDGREN

Losses in specific gravity of rough pine pulpwood after 2, 4, and 6 mo. of Summer storage (April 15 to October 15) in the Deep South ranged between 2 to 4, 6 to 8, and 8 to 10%, respectively. For corresponding periods of Winter storage, the losses were 0+ to 1.5, 1.5 to 3, and 3 to 5%. Peeled wood deteriorated most rapidly during the first several months of storage, regardless of season. Losses often exceeded those in rough wood for 2 to 3 mo.; with longer storage, they were progressively lower than in rough wood. Pulping trials by the U. S. Forest Products Laboratory showed little change in chemical composition of the wood during storage. Reductions in pulp yields on a wood volume basis were proportional to losses in specific gravity during storage. Measurable effects on sulphate pulp strength were indicated for pulpwood stored longer than 2 mo. in Summer and 5 mo. in Winter. The principal effect on groundwood pulp was a decrease in brightness. Contributing to low storage losses were: for rough wood—Winter storage, large bolt diameter, long bolt length, tight piling, fungicidal treatment of bolt ends; for peeled wood—quick peeling, open piling, small bolt diameter, splitting of large bolts, Winter storage, fungicidal treatment of entire bolt.

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EXPERIENCE with deterioration at mills has emphasized the need of avoiding long storage of southern pine pulpwood. All losses have not been eliminated, however, because oversupplies of pulpwood are in-

ritable at times if adequate reserves for emergencies are to be maintained. To such losses must be added the cost of frequent rotation of reserve supplies. This cost is no small item of expense in a region that produces and uses almost 15 million cords of wood annually.

Considering the importance of the problem, there has been a surprising lack of quantitative data on the amount of damage and practices that might reduce losses in stored southern pine pulpwood. The need for data of this type was indicated by Keaton and Gillespie (*7*) who reported that extended storage of rough wood had led to serious decay and appreciable losses in strength of pulp. Prior to the work summarized herein, literature revealed no references on even such basic aspects of the problem as the effect of length and season of storage on wood density and on pulp characteristics. Consequently, there has been little information on the practical questions of how long wood can be stored safely and what can be done to prolong safe storage periods.

The present studies were conducted from 1948 to 1951 in Mississippi, Louisiana, and Arkansas. Some of the results already have been covered in earlier publications (*4, 5, 6*). The first tests concentrated on the amount of damage that might be expected with the type of pulpwood and practices that are common at many mills. In later studies, attempts were made to determine the value of different methods of selecting, handling, and treating the wood as means of reducing losses. Part of the experimental material was pulped by the U. S. Forest Products Laboratory at Madison, Wis. The results of these pulping trials are considered to be indicative of the probable pulping characteristics of other test material of similar type and condition.

GENERAL METHODS

The many and diverse types of tests that were conducted make it impracticable to give more than a general outline of methods at this time. Most of the details of the experimental procedure were similar to those described in an earlier paper (*4*). For large-scale tests at mills, 50 bolts were used for each variable under study; for exploratory tests, the number varied from 10 to 25.

Both rough and peeled pulpwood stored at different seasons were sampled at intervals during periods up to one year. The four common southern pine species were represented in the test material. The bolts usually were 63 in. in length, 4 to 9 in. in diameter, and practically free of heartwood. In most tests, the pulpwood was bulk piled in ricks and stored with much larger quantities of material under conditions that were fairly typical of regular woodyard practice. Peeling was done by hand, usually within 1 day after cutting of the pulpwood. Specific comparisons involved such additional material as bolts that were (1) abnormally large or long, (2) not peeled until 1 mo. or more after cutting, (3) piled in open cribs, (4) treated either on ends or full length with fungicidal solutions.

The determinations of amount and type of deterioration, and of changes during storage in specific gravity and moisture content of the wood were based on 1-in. cross-sectional disks from each bolt. A single disk taken from one end of each freshly cut bolt was used as a representative sample of the bolt prior to storage. In dismantling the tests, similar 1-in. disks were sawed from the middle and at points about 9 in. from each end of the bolt. Averages of the data for the three disks were considered to represent conditions in the entire bolt after storage. Specific gravities were determined from the green volumes and oven-dry weights of the disks. Oven-dry weights were obtained by drying the disks at 104°C. to constant weight.

Methods of pulping the wood were described in detail in an earlier paper by McGovern, Martin, and Hyttinen (*6*).

AMOUNT OF LOSS IN STORED PULPWOOD

The amount of deterioration that occurred during storage is best represented by changes in specific gravity of the wood. The following losses were obtained in tests covering several years and four localities from southern Arkansas to the Gulf Coast. They are based on practices and types of pulpwood that are common at mills.

Losses in specific gravity of rough wood fell within the following ranges:

During Summer storage—April 15 to October 15
- 2 mo. of storage—2 to 4% (usually close to 2%)
- 4 mo. of storage—6 to 8%
- 6 mo. of storage—8 to 10%

During Winter storage—October 15 to April 15
- 2 mo. of storage—0+ to 1.5%
- 4 mo. of storage—1.5 to 3%
- 6 mo. of storage—3 to 5%

During 1 full year of storage—11 to 15%

Comparing southern Arkansas with Coastal localities, there was little difference between them in losses during Summer storage. During Winter storage, losses toward the lower limits of the indicated ranges were more typical for Arkansas than for Coastal storage conditions. In any part of the region, abnormally cold Winters tended to decrease losses, whereas warm Winters increased them.

Among factors other than weather that affected rate of deterioration were size of bolt and type of storage pile. Losses usually were more rapid if bolt size was small or if piles were of the open, aerated type. These and other factors will be discussed more fully.

Peeled pulpwood, unless of abnormally large size, deteriorated at a more variable rate than rough wood. The most rapid losses in specific gravity usually occurred during the first 3 to 4 mo. of storage, regardless of season; later deterioration was both slow and erratic. For bolts of average size, specific gravity was reduced 2 to 7% after 4 mo. and 3 to 9% after 1 yr. of storage; commonest losses, however, were 3 to 6 and 5 to 8%, respectively.

Peeled wood generally stored better in Winter than in Summer, but abnormal weather sometimes led to opposite results. Factors that greatly affected losses were size of bolt, type of piling, and rapidity of peeling. Losses toward the high side were favored by large bolt diameter, close (unaerated) piling, and long delays in peeling the pulpwood.

EFFECT OF STORAGE ON PULP CHARACTERISTICS

The pulping tests by the U. S. Forest Products Laboratory (*6*) were made on rough and peeled wood that was cut in October, 1948, and stored for different periods at Bogalusa, La. Yield and quality of sulphate and

groundwood pulps were determined for wood in the green condition and after storage for 4, 6, 9, and 12 mo.

The results of the pulping trials showed that chemical composition of the wood had changed little during storage. Loss of lignin, holocellulose, and alpha-cellulose was roughly in proportion to the loss in total density of the wood. Since percentage yield of pulp did not vary with changes in density, losses in yield of both sulphate and groundwood pulps on a wood volume basis were proportional to decreases in specific gravity of the pulpwood during storage. Such decreases during the four storage periods (starting in October) ranged from about 2% after 4 mo. to 14% after 1 yr. for rough wood, and from 3 to 6% for peeled wood.

In sulphate pulping, the only difference between green and stored wood was a small but definite increase in alkali consumption with increasing deterioration of the wood. Except for tensile strength, the sulphate pulps from stored wood showed lower strength properties than those from green wood. These losses in strength became evident first in the groups of rough and peeled wood that had been stored for 6 mo. The greatest reductions were in pulps from rough wood stored for 1 yr., in which they approximated 20% in bursting strength, 25% in tearing resistance, and 75% in folding endurance.

In groundwood pulping there were no important differences between green and stored wood for rate of grinding, energy consumption, distribution of fiber length, or pulp strength. The principal effect of storage was a decrease in pulp brightness; maximum decreases were 8 and 6 percentage points for rough and peeled wood, respectively.

Based on these results, measurable effects on sulphate pulp quality are indicated if losses in specific gravity of stored wood exceed about 3%. In the various storage tests, losses of 3% usually were reached in both rough and peeled wood after about 2 mo. of Summer and 5 mo. of Winter storage.

FACTORS AFFECTING DETERIORATION OF STORED PULPWOOD

Length and season of storage and weather conditions were among the most important factors that affected the amount of deterioration in stored wood. Their influence already has been indicated in the discussion of losses encountered in the test material.

Rough wood usually deteriorated steadily as storage periods lengthened. Losses during Winter storage were only one-half to one-third those for corresponding lengths of Summer storage; however, if the wood was stored 1 full year, the month of cutting and storing made no difference. Significant effects of abnormal weather were limited to either an increase or decrease in deterioration when Winter months were uncommonly warm or cold.

Peeled wood showed greatest losses during the first 3 to 4 mo. of storage. Winter storage usually resulted in the least deterioration, but not if the Winter was abnormally wet or the Summer dry. Long spells of wet weather at any time of the year tended to increase damage, particularly if they occurred during the first few months of storage. In general, abnormal conditions of moisture rather than of temperature had the greatest influence on losses in peeled wood.

There was no strong evidence in these tests that the several southern pine species differed appreciably in rate of deterioration. Indications were that loblolly pine might be susceptible to somewhat higher losses than the other species when stored as rough wood. However, the comparisons were too limited and not consistent enough to be significant.

Almost all losses in specific gravity of the stored pulpwood were caused by decay-producing fungi. One organism, *Peniophora gigantea*, was responsible for the major amount of damage in every test series. This fungus also has been recognized as the principal source of loss in pine pulpwood in the Southeastern, and even in the Lake States regions (*7*). *Peniophora* attacks both cellulose and lignin, causing little change in chemical composition of the wood. Therefore, it is understandable why the per cent losses in pulp yields from a given volume of wood were proportional to the reductions in specific gravity of the stored wood. This situation would not apply to a second fungus, *Lenzites saepiaria*, which became important in these tests after the wood had been stored for 6 mo. or longer. *Lenzites* destroys cellulose primarily, so its effect on pulp yields would exceed that indicated by losses in specific gravity of the wood.

Two other common deteriorating agents were sapwood staining fungi and wood-attacking insects. Discolorations caused by the sapstain fungi occurred as patches, streaks, or pie-shaped areas that varied in color from greenish-blue to black. They developed quickly in both rough and peeled wood, as described by Hepting (*1*), and were later obliterated by the more important decay. Sapstain was more prevalent in peeled than in rough wood and in Summer-cut than in Winter-cut bolts. It appeared earlier at the ends than the midparts of rough bolts, but was fairly evenly distributed within peeled bolts. Except for entrance through ends, the development of stain in rough wood usually was associated with insect attack.

Insect attack was of little importance in peeled wood if the bark was removed shortly after cutting of the bolts. Rough wood showed varying degrees of attack by bark beetles and wood borers in all test series. Nevertheless, the amount of wood lost due to tunneling by insects was relatively minor.

Rough bolts of large diameter tended to decay slower than those of smaller size. Losses in specific gravity of 8 to 10-in. bolts often were only 60 to 70%, and sometimes as low as 50%, of those in 4 or 5-in. ones. Large bolts also were very slow to lose moisture during storage, which may have been a factor in retarding their early decay.

With peeled wood the opposite was true; progressively higher losses occurred in large than in small wood as storage periods lengthened. In one test, for example, specific gravities of bolts averaging about 6 and 13 in. in diameter were reduced approximately 7% in both groups after 4 mo. of storage; losses after 1 yr. of storage, however, were 8% for the small and 14% for the large bolt groups. Splitting of large bolts into halves before storage resulted in losses that were closely similar to those for the smaller wood. The explanation for these differences rested in the rapid drying of the small and split bolts. Such drying brought moisture contents within a few months to levels that

were insufficient for rapid decay development. Large wood, on the other hand, maintained favorable moisture contents for the decay fungi over much longer periods.

In rough wood of normal length, decay invariably developed more rapidly in the ends than in the mid-parts of the bolts. Often, little deterioration was evident in the middle region when losses in specific gravity of 5% or more had been reached near the bolt ends. These differences in deterioration within the bolt became less pronounced as the length of storage increased. In a comparison of 4 and 8-ft. bolts, the computed over-all losses in specific gravity after 9 mo. of storage were 9.6 and 4.6%, respectively, for the two groups. Decay still was not far advanced in the mid-part of the long bolts whereas specific gravity had been reduced as much as 10 to 12% toward the ends.

Peeled bolts showed no striking variations in losses in specific gravity in different parts of the bolts.

Delays in peeling the pulpwood led to losses in specific gravity that were abnormally high for peeled wood. This was true especially for the occasional practice of permitting insect attack to loosen the bark before final peeling and storage. Peeling that was delayed for 4 to 6 weeks in Summer resulted in losses that were from one fourth to two fifths greater than those in quickly peeled wood. Similar delays in peeling during the Winter months undoubtedly would have been much less damaging.

In rough bolts, moisture contents of the wood still favored fairly rapid decay in wood that had been stored for as long as a year (moisture contents after 1 yr. ranged from 30 to 45%, total weight basis). Such slow drying indicated that attempts to accelerate drying of the bolts offered little promise as a control measure. Furthermore, topmost bolts in piles usually were heavily damaged, and losses were at least as high in small, open cribs as in large, tight stacks. Indications were that greater benefit would result from piling methods that slowed down, rather than hastened, the loss of moisture from rough woods.

Peeled bolts usually dried rather rapidly so that insufficient moisture eventually became a limiting factor in further decay development. In most test groups, moisture contents dropped from 55 to 60% to 20 to 25% during the first 4 mo. of storage. The rapidity of drying and the absence of decay in bolts varied directly with the amount of ventilation provided by the method of piling. Open crib-piled bolts seldom lost more than 3% in specific gravity, even after 1 yr. of storage. On the other hand, losses tended to be high in piles that were so poorly aerated that drying of the bolts was slow.

In rough bolts, immediate spraying of freshly cut ends with a water solution of either 4% sodium fluoride or 5% ammonium bifluoride often reduced losses to half or less those in untreated bolts. Such sprays prevented or greatly delayed the entrance of decay fungi through the exposed ends. Eventually, decay became established both in the ends and sides of the bolts as a result of insect attack and bark loosening. Delays of several days or longer in applying the solution to freshly cut ends led to diminishing control of decay by the fluoride treatments. Nevertheless, they proved more effective, both as immediate or delayed treatments, than solutions containing the common chlorinated phenol or organic mercurial fungicides (*5*).

On peeled wood also, fluoride solutions applied to the entire bolt were the most promising decay control treatments tested. They were most superior over other treatments when conditions permitted only slow drying of the wood, and when spraying was delayed for several days after peeling. Immediate applications of the fluoride treatment practically eliminated decay in some of the test series stored for as long as a year; in all other tests, they reduced losses to less than half the amount recorded in untreated bolts.

Earlier mention was made (*5*) that the fluoride treatments encourage the heavy development on pine pulpwood of a common green mold (*Trichoderma*) that has little effect on specific gravity and strength of the wood. This mold seems to contribute to control of the important decay fungi in fluoride sprayed wood, either through an antibiotic or straight competitive effect. It also greatly increases the permeability of the wood to penetration by liquids. Unpublished tests by the Forest Products Laboratory, Madison, Wis.,* disclosed that less screening rejects were obtained from fluoride treated and molded than from untreated wood when making kraft-type pulps in a yield near 52% and having a lignin content of about 9%. Uniform chips having dimensions of $^1/_8$ in. in thickness and $^5/_8$ in. in the grain direction were used. This slight improvement in pulping was recognized as important possibly to a mill using large, thick chips of nonuniform size and shape, or to a mill pulping to a high yield. However, strength properties of pulps from the molded wood were slightly lower than those from untreated wood.

CONCLUSIONS ON PRACTICES FOR REDUCING LOSSES

The practices of storing pulpwood only as long as is necessary and of pulping the oldest stored material first are widely recognized as the first line of defense in minimizing losses in both rough and peeled wood.

Peeling greatly reduces losses during extended storage, but some qualification in its use as a practice is necessary in the Deep South. In these tests, peeled bolts showed more sapstain and decay and greater losses in specific gravity than rough wood during the first 2 mo. of Summer and 4 to 5 mo. of Winter storage. For storage periods no longer than these, it seemed preferable to leave the bark intact rather than to remove it. For longer storage periods, a progressive advantage toward lower losses can be expected from peeling.

Rough Pulpwood

The tests indicated that storage losses in rough wood could be reduced by:

Cutting and storing during late Fall and Winter. (For storage periods of 12 mo., time of cutting makes no difference.)

Storing bolts of as large diameter as possible. Large bolts also average higher in initial specific gravity and require less space than small wood so that fewer cords would be needed for storing equivalent amounts of pulp.

Storing bolts of as long length as possible.

Spraying ends of freshly cut bolts with 4% sodium fluoride or 5% ammonium bifluoride in water. Early

* Office Report, "Sulphate Pulping of Fluoride-Preserved Slash Pine," by the Division of Pulp and Paper, Forest Products Laboratory, Madision, Wis., October, 1952.

application is needed for effective results from such sprays.

Storing quickly after cutting in large, tight piles.

Storing in water. The foregoing practices will slow down but will not prevent eventual deterioration. Therefore, their use will not permit storage for the almost indefinite periods that are possible when freshly cut pulpwood is submerged in water. Although not tried in these tests, the protection afforded by water storage is well known. The practicability of the method seems worthy of trial, now that bundling of pulpwood (*3*) offers promise of facilitating the handling of bolts.

Peeled Pulpwood

Peeling as quickly as possible after cutting.

Storing in open, well-ventilated piles.

Splitting of large bolts or favoring small bolts for storage.

Storing during Fall and Winter (unless weather is abnormally wet).

Spraying or dipping the entire bolt immediately after peeling with 4% sodium fluoride or 5% ammonium bifluoride in water.

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Studies on Modified Cellulose

III. Characterization of the Reactivity and Supermolecular Structure Cellulose Fibers

ALEXANDER MELLER

A mathematical expression has been derived by which the constants of the rates governing the reactions with the difficultly and a portion of the easily reacting fractions of cellulose fibers can be characterized. Knowing these constants, the relative amounts of the easily and difficultly reacting fractions can also be assessed. The usefulness of the equation derived has been demonstrated by applying it to experimental results obtained by acid hydrolysis of different wood pulps and tire cord rayon as well as by conversion of ammonia cellulose by metallic sodium. The need for a full characterization of both the easily and difficultly reacting fractions of cellulose fibers is stressed, as discussed previously. This full characterization concerns a portion of the easily reacting fraction which seems to react according to a mechanism controlled by a diffusion process in the solid structure of the fibers. Evaluation of data taken from a recent publication on the removal of lignosulphonic acid by water lends further support to this view.

The course of many heterogeneous degradation as well as conversion reactions with cellulose fibers seems to be governed by their supermolecular structure. The rate plots of such reactions have the common feature of an initial rapid rise followed by an apparent steadiness. Some of these rate plots show a practically straight branch in the advanced stages of the reaction (*1–5*). It is customary to regard such rate plots as composed of two components. One would represent a fast reaction with the readily reacting fraction of the fibers superimposed on a second slow reaction with the sluggishly reacting fraction. By resolving such rate plots into the constituents, the relative amounts of these fractions have been evaluated by many authors (*3, 6*).

It was suggested recently that the rate controlling mechanism involved in the hydrolytic removal of the readily reacting fraction changes during the course of the reaction (*6*). This suggestion was based on consideration of the magnitudes of the activation energies derived from rate constants which were evaluated from the results of rate measurements conducted at different temperatures. The hydrolytic removal of the readily reactive fraction of cellulose fibers thus appears to take place in three apparent successive steps, each being governed by a different reaction mechanism. It was also advanced that the rate constants of these three steps and the rate constant of the reaction with the difficultly reactive fraction may serve to characterize the reactivity of cellulose fibers in heterogeneous reactions as well as the supermolecular structure of the fibers (*6*).

The most common procedure for resolving the rate plots of such heterogeneous cellulose reactions is based on inspection; a straight line is drawn through the origin with a gradient equal to that of the straight (or approximately straight) part of the rate plots. By subtracting this straight line from the total curve the constituent curve is obtained. By proceeding in this manner the uncertainty as to the point from which the plots should be regarded as straight causes some difficulties. A large number of experimental points are required to ascertain the gradient of the straight branch

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of the plots. This fact makes long experimentation necessary. Since the results of experiments conducted for a long period may not always be free from effects of side reactions, such results may not always be satisfactory. Reference should be made in this connection, for example, to humic acids formed when the acid hydrolysis technique is applied. Since these humic substances are, to a large extent, insoluble in the reaction mixture they are deposited on the residues filtered off and weighed. They introduce some errors due to their weight and to a possible blocking of the surface of the test sample. Entirely satisfactory solvents for these humic substances do not seem to have been found although the application of monoethanolamine has been advanced (*7*). However, control experiments have indicated that this reagent dissolves degraded cellulose to a small extent as well.

Assuming that the rate plots of some of the heterogeneous degradation and conversion reactions of cellulose are a superposition of a curve upon a straight line, the plots may be resolved by mathematical methods. Such methods would eliminate the uncertainty of drawing the straight line component based on inspection as well as the necessity for long experimentation.

The object of the work described in the present paper was (1) to derive a mathematical expression for resolving the rate plots of heterogeneous cellulose reactions into components, and (2) to evaluate the constants of the component curve and straight line in order to characterize the reactivity of cellulose fibers. The usefulness of the mathematical equation derived is demonstrated on examples taken from the literature as well as from the author's own work.

METHOD OF RESOLVING THE RATE PLOTS OF HETEROGENEOUS CELLULOSE REACTIONS AND CHARACTERIZATION OF THE REACTIVITY OF CELLULOSE FIBERS

Derivation of the Equation

Denoting the extent of the reaction with the difficultly and easily reacting fractions by x_1 and x_2 and the extent of the total reaction by x, then at any instant

$$x = x_1 + x_2$$

and

$$a = a_2 + a_2$$

where

a = total amount of sample (=100)
a_1 = initial amount of difficultly hydrolyzable fraction
a_2 = initial amount of easily hydrolyzable fraction

If the relationship between x_1 and time of reaction (t) is linear from $t = 0$ onwards, and between one portion of x_2 (x_2'') and time (t'') from a certain time value ($t + c$) is exponential, then

$$x = k_1 t + a_2'' + b - a_2'' e^{-k_2(t + c)} \qquad (1)$$

k_1 = rate constant of the slow reaction
k_2 = rate constant of the fast first order reaction
$a_2'' + b = a_2$ = initial amount of the fast reacting fraction
a_2'' = portion of the fast reacting fraction which is hydrolytically removed according to a first order law
b = portion of the fast reacting fraction, the hydrolysis of which is not according to a first order law
c = the difference between the time of removal of the entire fast hydrolyzable fraction and the time of removal of the portion of the fast reacting fraction hydrolyzed according to a first order law

On substituting known experimental values of x and into equation (1), the constants k_1 and k_2 and the amounts of the slowly and fast reacting fractions (a_1 and a_2) cannot be easily determined by solving the simultaneous equations.

Denoting the rate of the reaction with the easily hydrolyzable fraction by dx_2/dt and that with the difficultly reacting fraction by dx_1/dt and substituting into equation (1), we obtain for the rate of the total reaction

$$\frac{dx}{dt} = k_1 + k_2(a_2 - x_2) \qquad (2)$$

Since

$$x_2 = x - k_1 t$$

and

$$a = a_1 + a_2$$

on substituting into equation (2), we obtain

$$\frac{dx}{dt} = k_1 + k_2 a_1 + k_2 a - k_2 x + k_1 k_2 t \qquad (3)$$

Taking dx/dt values and x values corresponding to such t values where the difference between these t values is the same, and calling these differences of dx/dt and x values "increment dx/dt" and "increment x," we can write

$$\text{Increment } \frac{dx}{dt} = \tau k_2 \qquad \text{increment } x = k_1 k_2 \tau \qquad (M)$$

where τ is the time interval chosen for the increments (see Appendix).

A plot of the increments of dx/dt against the increments of x is a straight line with the gradient of k_2, and the intercept with the ordinate is $-k_1 k_2\ \tau$. Thus by evaluating the gradient and the intercept, the constants k_1 and k_2 can be determined.

By subtracting from the experimental x-values the corresponding $k_1 t = x_1$ values, values for x_2 are obtained.

In order to obtain a_2, the values of dx_2/dt are plotted against the x_2 values, resulting in a curve and terminating in a straight line with the gradient of k_2, and the intercept with the ordinate is $k_2 a_2$; since $dx_2/dt = k_2(a_2 - x_2) = k_2 a_2 - k_2 x_2$. On evaluating this intercept, the value of $a_2 = a_2'' + b$ can be computed.

The values of a_2'', b, and c can only be determined approximately. A plot of log $(a_2 - x_2)$ against t is a curve terminating in a straight line with the gradient of k_2 and the intercept with the ordinate is the sum of two constants [log $(a_2 - x_2)$ = log $a_2'' - k_2(t + c)$] which cannot be easily separated.

Only approximate values of a_2'', b, and c may be found from this plot since the curve merges into a straight line and the point at which the curve changes into a straight line cannot be determined accurately (*6*).

Application of the Equation to the Author's Results Obtained by Hydrolysis of Wood Pulps

In order to demonstrate the usefulness of the equations, the following examples are evaluated.

An acetate grade wood pulp, hydrolyzed by 8% hydrochloric acid at 80 and 100°C. resulted in losses in weight, as listed below (*3*).

Time, hr. (t)	Loss in weight %: x_{80} experimental 80°C.	Loss in weight %: x_{80}[a] calculated 80°C.	Loss in weight %: x_{100} experimental 100°C.	Loss in weight %: x_{100}[b] calculated 100°C.
0.5	1.2	...	3.3	...
1	1.8	2.08	6.4	7.0
2	3.2	3.19	9.5	9.5
3	3.85	3.95	11.5	11.4
4	4.50	4.54	...	...
6	5.50	5.38	15.2	15.6
8	5.95	5.94	...	...
12	6.60	6.74	22.4	22.4
24	8.50	8.60	...	...

[a] $x_{80} = 0.15t + 5.0 - 4.4e^{-0.36t}$; $k_1 = 0.15$; $k_2 = 0.36$; $a_2 = a_2''' + b = 5.0$; $a_2''' \cdot e^{-k_2 c} = 4.4$.

[b] $x_{100} = 1.10t + 9.2 - 5.65e^{-0.54t}$; $k_1 = 1.10$; $k_2 = 0.54$; $a_2 = a_2''' + b = 9.2$; $a_2''' \cdot e^{-k_2 c} = 5.65$.

Application of the Equation to Results from the Literature

A sulphate wood pulp and a tire cord rayon sample hydrolyzed with 2.5 *N* sulphuric acid at 96°C. resulted in losses as listed below. These results were reported by Roseveare (*8*).

Time, hr. (t)	Loss in weight, %: $x_{S.P.}$ experimental (sulphate pulp)	Loss in weight, %: $x_{S.P.}$ calculated[a]	Loss in weight, %: $x_{T.C.}$ experimental (tire cord rayon)	Loss in weight, %: $x_{T.C.}$ calculated[b]
1.5	3.41	...	9.55	...
3.0	5.25	5.35	13.20	13.40
4.0	6.20	6.31	15.20	15.30
4.75	6.85	6.90	16.30	16.50
5.5	7.33	7.44	17.40	17.30
8.0	8.70	8.72	19.90	19.80

[a] $x_{S.P.} = 0.25t + 7.43 - 6.7e^{-t0.30}$; $k_1 = 0.25$; $k_2 = 0.30$; $a_2 = a_2''' + b = 7.33$; $a_2''' \cdot e^{-k_2 c} = 6.7$.

[b] $x_{T.C.} = 0.52t + 16.7 - 11.7e^{-t0.02}$; $k_1 = 0.52$; $k_2 = 0.30$; $a_2 = a_2''' + b = 16.7$; $a_2''' \cdot e^{-k_2 c} = 11.7$.

An ammonia cellulose sample (derived from viscose rayon) converted with metallic sodium in liquid ammonia at 33°C. resulted in values listed below. These results were reported by Timell (*4*).

Time, min.	Conversion, % experimental x	Conversion, % Calculated[a] x
5	13.1	...
20	38.2	...
36	51.2	51.5
51	54.7	54.8
80	58.4	58.7
110	60.5	60.6
172	62.5	62.3
230	63.1	63.4
247	63.4	63.5

[a] $x = 0.015t + 59.9 - 26.2e^{-0.03t}$

DISCUSSION

The equation derived has been applied to results of rate measurements of the heterogeneous acid hydrolysis of cellulose samples, represented by an acetate grade wood pulp, sulphate wood pulp, and regenerated cellulose (tire cord rayon).

By the application of the equation referred to above as equation (M), the constants of the hydrolytic removal of the difficultly hydrolyzable fraction and of a portion of the easily hydrolyzable fraction, which follows a kinetically first order law, has been computed. Once these constants are determined, the amounts of difficultly and easily hydrolyzable fractions can also be determined as shown above.

Reference should be made to the temperature coefficients of the constants k_1 and k_2 evaluated from the hydrolysis rate measurements of the acetate grade pulp.

The temperature of coefficient of the constant of the rate of reaction (k_1) with the difficultly hydrolyzable fraction of the acetate grade wood pulp is comparatively high. It amounts to 1.1/0.15 for a 20°C. temperature interval. The temperature coefficient of the constant of the rate of reaction (k_2) with a portion of the easily hydrolyzable fraction amounts to 0.54/0.36 for a 20°C. interval. This low magnitude of the temperature coefficient suggests that the mechanism controlling the rate of hydrolytic removal of a portion of the readily hydrolyzable fraction of the fibers is essentially a diffusion through a liquid film (*6*). The portion of the easily hydrolyzable fraction which is not removed either by a film diffusion mechanism, or by a reaction the rate of which follows a kinetically first order law, can only be determined approximately. It was discussed in a previous paper that this portion of the fibers is removed in acid hydrolysis by a mechanism which appeared to be a diffusion in the solid structure of the fibers and possibly a sorption process (*6*).

The finding that the hydrolytic removal of the easily reacting fraction is initially very fast and slows down at the later stages of hydrolysis was explained by a "retardation" effect (*6*). This retardation was thought to be caused by (1) the reaction products covering the surface of the fibers during hydrolysis, (2) a progressive saturation of the acid solution by the degradation products, (3) a change in the viscosity of the solution containing fragmented cellulose and glucose and (4) a progressively decreasing surface during the reaction which would result from a recrystallization of the amorphous cellulose segments. Such recrystallization during acid hydrolysis of cellulose fibers has been postulated to occur by several investigators (*8–19*). Roseveare (*8*) states that the plots of log $a/(a - x)$ against time (x = per cent loss in weight and a = initial amount of cellulose) do not go through the origin because of a higher rate of hydrolysis before completion of crystallization. This author evaluated the results of hydrolysis rate measurements by means of a kinetically first order reaction equation, applying the loss in weight values for the times after a presumed completion of crystallization on hydrolysis, but before a significant amount of the slowly reacting material has reacted. Since the contribution of the slowly reacting material may not be negligibly small, he realized that an "exact agreement with the first order reaction behavior is not to be expected." The expressions used in the present paper contain the term which takes into consideration the slowly hydrolyzable material ($k_1 t = x_1$). If this is taken into account, then the difficultly hydrolyzable as well as the easily hydrolyzable fractions may be characterized by the constants k_1 and k_2. As discussed recently, and referred to above, the full characterization of the easily hydrolyzable fraction may be done by two further constants, one of which seems to be related to a solid diffusion reaction and the other to a sorption (swelling) process (*6*).

The table below lists the constants k_1, k_2, and the relative amounts of easily and difficultly hydrolyzable fractions (a_1 and a_2), as evaluated by the method described above. They may be useful for comparison.

The acetate grade wood pulp seems to possess both a very reactive "crystalline" and "noncrystalline" fraction. Probably both factors play a role when this pulp

Pulp	Hydrolysis temperature, °C.	a_1	a_2	k_1	k_2	$a_2'''e^{-k_2c}$	Hyhrolyzing solution
Acetate grade wood pulp (*3, 6*) ("Rayceta")	100	90.8	9.2	1.10	0.54	5.65	Hydrochloric acid, 8%
	80	95.0	5.0	4.40	0.36	4.40	
Viscose grade wood pulp (*3, 6*)	100	87.0	13.0	0.94	0.16	9.0	Hydrochloric acid, 8%
	90	89.7	10.3	0.33	0.14	6.8	
	80	91.6	8.4	0.11	0.12	5.9	
Cotton fibers (*3, 6*)	100	93.0	7.0	0.59	0.20	4.1	Hydrochloric acid, 8%
	90	92.4	5.8	0.20	0.17	3.9	
	80	95.3	4.7	0.067	0.15	3.7	
Sulphate wood pulp (*8*)	96	92.67	7.33	0.25	0.30	6.7	Sulphuric acid 2.5 *N*
Tire cord rayon	96	83.3	16.7	0.52	0.30	11.7	

is converted into cellulose acetates. The reactivity of the difficultly hydrolyzable fraction of the cotton and sulphate wood pulp samples is very low. This may be concordant with experience on the behavior of cotton cellulose in many cellulose conversion processes.

In the foregoing discussion, reference was made to the characterization of the portion of the easily reacting fraction of cellulose fibers which does not react according to a kinetically first order law.

In a previous paper, the procedure for evaluating two constants, which may characterize this portion, was described (*6*). These constants are related to rates of reactions which seem to control the hydrolytic removal of readily reacting material in the early stages of hydrolysis. Based on the magnitudes of temperature coefficient of these constants, it was postulated that initially swelling or sorption and later diffusion in the solid structure of the fibers may be the rate controlling processes in the hydrolytic removal of a portion of the readily reacting fraction. For characterizing the solid diffusion controlled reaction a parabolic equation was suggested (*6*). Recently Kullgren (*20*) applied a similar parabolic equation (kinetically zero order retarded reaction) to describe the rate of dissolution of lignosulphonic acid from sulphite pulps by water: $x^2 = ct$. Here x is the amount of lignosulphonic acid dissolved per gram of test sample, t the time of extraction, and c is a constant. This equation originates from the rate equation: $dx/dt = k/x$. The rate constant evaluated from the experimental results showed a good constancy for the greater part of the experimental range, but changed in the later stages of the dissolution process. Kullgren gives two values for the amount of lignosulphonic acid dissolved at 25 and 100°C. On taking the times needed at both temperatures for dissolving the same amount of lignosulphonic acid, he calculated that the temperature coefficient for the rate amounted to 2.9 for 10°C. temperature interval. He concluded that the dissolution of lignosulphonic acid is not diffusion controlled. However, he only used one pair of values and the value of x at room temperature was taken from the range where the parabolic equation was not applicable and probably the process was not diffusion controlled. The value of x taken at 100°C. may have been from the range where solid diffusion was the rate controlling process. Taking another pair of values (30 min. for dissolving 11.1 mg. at 100°C. and 406 min. at room temperature), the temperature coefficient for the rate of dissolution amounts to 1.4. This temperature coefficient suggests that the dissolution of lignosulphonic acid is controlled by a diffusion process in the solid structure of the fibers, and compares very favorably with the conclusions drawn by the writer (*6*).

It seems, therefore, that certain reactions with cellulose fibers are controlled by a diffusion process in their solid structure, and it is reasonable to expect that the rate constants characterizing the rate equation of such reactions may give useful information on their supermolecular structure. In order to characterize the reactivity of cellulose fibers fully, due consideration should be given to these aspects.

APPENDIX

If a rate plot of a reaction represents the superposition of a straight line (zero order reaction: $dx_1/dt = k_1$) upon an exponential curve (first order reaction: $dx_2/dt = k_2(a_2 - x_2)$), the rate of the net reaction is:

$$\frac{dx}{dt} = \frac{dx_1}{dt} + \frac{dx_2}{dt} = k_1 + k_2(a_2 - x_2) \qquad \text{(A)}$$

If the initial concentration of the total material reacting is a, the initial concentration of the reactant which reacts according to a zero order law is $a_1 = a - a_2$.

The concentration of the total material which has reacted is x and is equal to $x_1 + x_2$.

Thus

$$a = a_1 + a_2$$

and

$$x = x_1 + x_2$$

or

$$x = k_1t + x_2$$

Substituting into equation (A)

$$\frac{dx}{dt} = k_1 + k_2a - k_2a_1 - k_2x + k_1k_2t$$

Taking dx/dt and x values corresponding to the same time intervals

$$\left(\frac{dx}{dt}\right)_{t:1} = k_1 + k_2a - k_2a_1 - k_2x_{t:1} + k_1k_2t_{t:1}$$

$$\left(\frac{dx}{dt}\right)_{t:2} = k_1 + k_2a - k_2a_1 - k_2x_{t:2} + k_1k_2t_{t:2}$$

and subtracting gives

$$\text{Increment}\left(\frac{dx}{dt}\right) = k_2 \qquad \text{increment } x = k_1k_2 \cdot \text{time interval}$$

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Use of Aluminum Chloride in Melamine-Treated Papers

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The use of melamine resin for preparing high wet-strength papers has gained general recognition in the trade. The advantages of using aluminum chloride in place of aluminum sulphate for precipitating the beater size when using melamine resin has not been adequately presented in the technical literature. Although the price of aluminum chloride is several times greater than alum a considerable saving in paper manufacturing costs may be realized. This is accomplished by being able to make a drastic reduction in the melamine resin furnish without any sacrifice in wet strength. Data represented by actual machine production showing the advantages of aluminum chloride with melamine resin-treated paper are given. The results of these machine data cover beater furnishes with high alpha-cellulose and bleached rag stock.

The manufacture of wet-strength papers using melamine formaldehyde resin has been reported by Maxwell (*1*) giving the physical properties of the paper, preparation of the resin-acid colloid, and general applications. Landes and Maxwell (*2*) have also given the results of operating variables and laboratory data on the study of the melamine-alum system. The effect of multivalent anions on the effectiveness of the melamine resin colloid as a wet-strength agent has been discussed by Maxwell and Reynolds (*3*) and methods of resin addition have been suggested to obtain the best results. The use of aluminum chloride as a substitute for papermakers' alum in setting the beater size is given by Porter and Lane (*4*). The effect of the sulphate ion on cationic urea-formaldehyde resin is given by Gruntfest, Young, and Moser (*5*).

The technical literature gives very little data on the preparation of wet-strength papers using aluminum chloride as a substitute for aluminum sulphate for precipitating the beater size when using melamine resin. The results of actual machine data have shown that a very substantial saving may be realized in the melamine resin furnish when using aluminum chloride which has led to the installation of a special storage and distribution system for handling liquid aluminum chloride for continuous full-scale production of wet-strength papers (see Boughton (*6*)).

MACHINE TRIALS

Machine trials involved the slushing of the fiber furnish in a hydrapulper and the addition of a beater size followed by the addition of a standard aluminum chloride solution for precipitating the size. The sized stock is pumped to the machine chest and jordaned on to the machine.

All of the data reported are based on the use of aluminum chloride at the same Al_2O_3 equivalent as the aluminum sulphate furnish. This has been found satisfactory as evidenced by the maintenance of the same penetration values for the paper.

Using a high alpha-cellulose fiber furnish the results of a typical machine run are given in Table I. The headbox pH was held at about 4.5. In Fig. 1 the per cent melamine resin added to the stock after the jordan, based on the moisture-free fiber, is plotted against the wet burst for each part. The results indicate the tremendous advantage for the aluminum chloride system, and the resultant reduction in melamine resin furnish that could be made and still maintain a wet burst equivalent to the aluminum sulphate system. It is also evident that wet strengths may be attained that are not even possible with the aluminum sulphate furnish.

The results of two other typical machine runs are given in Table II. The fiber furnish and size addition are similar to the previous example but illustrate differences in basis weight and stock preparation. In the case of 2A and C the aluminum chloride system gives a better wet burst using half the melamine resin furnish than the aluminum sulphate system, while in the example of 3A and C only a quarter of the melamine resin is required to obtain approximately the same wet burst.

The best point of application of the melamine resin

Table I. Machine Data on High Alpha-Cellulose Furnish
Basis weight 20½ lb. per 1000 sq. ft.

Machine trial	*Beater furnish*	*Melamine resin added, %*[a]	*Bursting strength Dry*	*Bursting strength Wet*[b]
1A	Aluminum chloride	0	27	1
B	Aluminum chloride	½	37	8
C	Aluminum chloride	1	42	12
D	Aluminum chloride	3	42	18
E	Aluminum chloride	5	45	22
F	Aluminum sulphate	0	35	1
G	Aluminum sulphate	½	36	2¾
H	Aluminum sulphate	1	30	4¼
I	Aluminum sulphate	3	32	7½
J	Aluminum sulphate	5	36	9½

[a] Per cent resin added to moisture-free fiber after jordan.
[b] Based on 2-hr. soak in water at 70°F.

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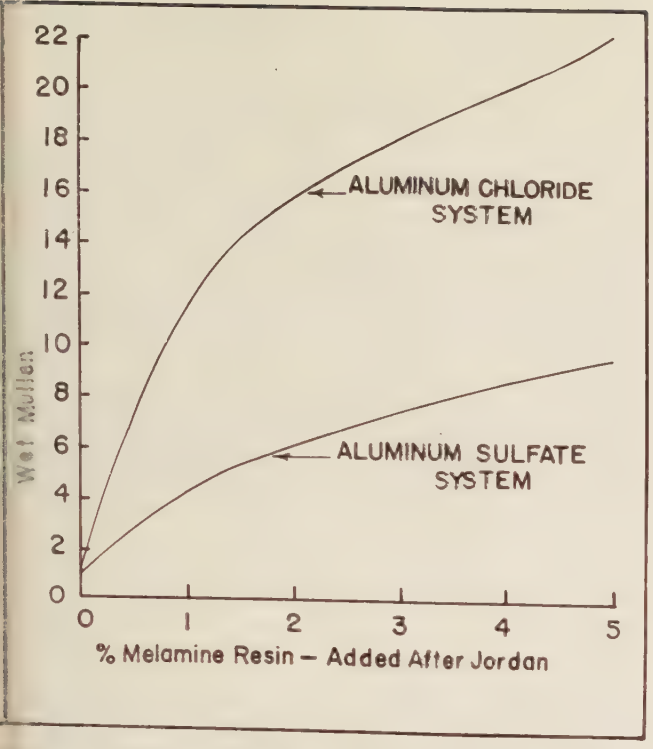

Fig. 1. Influence of per cent melamine resin added after jordan on wet-bursting strength

to the stock has been the question of considerable study. The results of a typical machine run, varying the point of addition, are given in Table III. The melamine resin

Table II. Machine Data on High Alpha-Cellulose Furnish Giving Results for Different Weight Grades

Machine trial	*Beater furnish*	*Melamine resin, %*[a]	*Basis weight*[b]	*Bursting strength* *Dry*	*Wet*[c]
2A	Aluminum chloride	1 1/2	28 1/4	48	11
B	Aluminum sulphate	1 1/2	26 1/4	46	5 3/4
C	Aluminum sulphate	3	28 1/2	46	8 1/2
3A	Aluminum chloride	1/4	54 1/4	62	10
B	Aluminum chloride	1/2	54	61	14
C	Aluminum sulphate	1	55	62	10 1/2

[a] Per cent resin added to moisture-free fiber after jordan.
[b] Basis weight in pounds per 1000 sq. ft.
[c] Based on 2-hr. soak in water at 70°F.

in the run 4A was added to the slushed stock in the hydrapulper prior to the addition of the beater size and the aluminum chloride. 4A and B show the difference, using an aluminum chloride furnish, on the wet burst between addition of the melamine resin to the slushed stock in the hydrapulper and the addition after the jordan. The melamine resin in the run of 4C was added to the stock in the hydrapulper prior to the beater size and aluminum sulphate.

Table III. Machine Data on High Alpha-Cellulose Furnish Comparing Melamine Resin Addition After Jordan Versus the Beater

Basis weight 26 lb. per 1000 sq. ft.

Machine trial	*Beater furnish*	*Melamine resin* *Per cent*	*Addition*[a]	*Bursting strength* *Dry*	*Wet*[b]
4A	Aluminum chloride	1	Hydrapulper	55	14 1/4
B	Aluminum chloride	1	After jordan	65	35
C	Aluminum sulphate	2	Hydrapulper	58	19 1/4

[a] Per cent resin added to moisture-free fiber.
[b] Based on 2-hr. soak in water at 70°F.

Table IV. Comparison of Urea and Melamine Resins with a High Alpha-Cellulose

Machine trial	*Beater furnish*	*Resin* *Type*	*Per cent*[a]	*Basis weight*[b]	*Bursting strength* *Dry*	*Wet*[c]
5A	Aluminum chloride	Melamine	1	20 3/4	41	12
B	Aluminum chloride	Urea	2	20 1/2	32	5
6A	Aluminum chloride	Melamine	1/4	42 1/4	56	12
B	Aluminum chloride	Urea	1/2	41 1/4	48	8
C	Aluminum chloride	Urea	1	41	51	10 1/2

[a] Per cent resin added to moisture-free fiber after jordan.
[b] Basis weight in pounds per 1000 sq. ft.
[c] Based on 2-hr. soak in water at 70°F.

Limited machine runs were made comparing two typical urea-formaldehyde resins against the melamine resin as shown in Table IV. Based on the results of these tests the urea-formaldehyde resins are not equivalent to the melamine resin for producing wet bursting strength.

Machine runs have also been made using a bleached rag furnish. Table V shows that a 3% melamine resin addition after the jordan in an aluminum sulphate system is necessary to obtain an equivalent wet burst when using only 1 1/2% resin in the aluminum chloride system.

These results are typical of many actual machine runs and have led to the adoption of aluminum chloride for precipitating the beater size in all regular production involving the manufacture of wet-strength papers with melamine resin.

CHEMICAL SAVINGS

Referring again to Fig. 1, it is obvious that for this given wet-strength paper grade only 1/2% melamine resin is required to obtain a wet burst of 8 in the aluminum chloride system, while 3 1/2% of the resin is required in the aluminum sulphate system. Using current costs for the aluminum chloride solution, the commercial papermakers' alum, and based on equivalent Al_2O_3

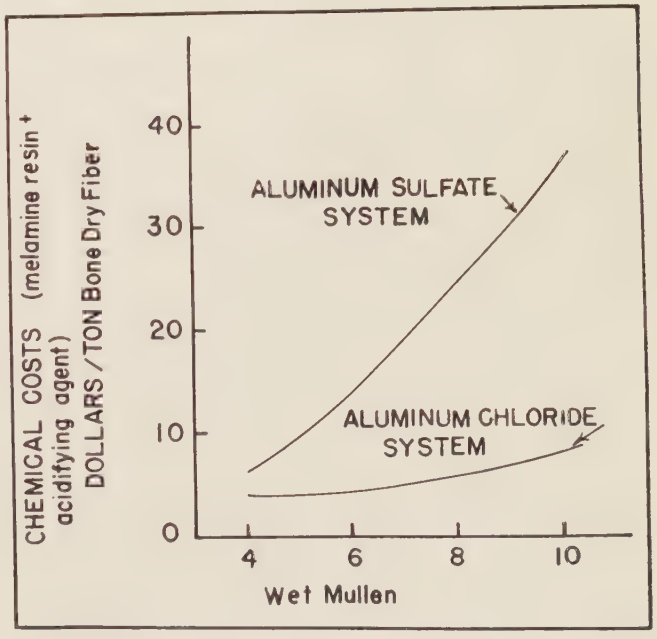
CHEMICAL COSTS (melamine resin + acidifying agent)
DOLLARS / TON Bone Dry Fiber
ALUMINUM SULFATE SYSTEM
ALUMINUM CHLORIDE SYSTEM
Wet Mullen

Fig. 2. Chemical costs as influenced by wet-bursting strength

Table V. Machine Data on Bleached-Rag Furnish

Machine trial	Beater furnish	Melamine resin, %[a]	Basis weight[b]	Bursting strength Dry	Bursting strength Wet[c]
7A	Aluminum sulphate	3	25	61	39 1/4
B	Aluminum sulphate	2	21 1/4	53	28 1/2
C	Aluminum chloride	1 1/2	23 3/4	72	39

[a] Per cent resin added to moisture-free fiber after jordan.
[b] Basis weight in pounds per 1000 sq. ft.
[c] Based on 2-hr. soak in water at 70°F.

in the stock furnish for sizing, the cost of chemicals (melamine resin plus acidifying agent for beater size precipitation) may be plotted against the equivalent wet burst. The results are shown in Fig. 2. Assuming a production rate of 50 tons per day with a wet burst of 8, a saving of over $230,000 per year is obtained. This is only given to illustrate the economies that can be realized by using an aluminum chloride system with the melamine resin. The data here given are specific for only this furnish and machine conditions but results of similar studies on other grades have generally shown this advantage.

STORAGE SYSTEM

Initial trials were run using crystalline $AlCl_3 \cdot 6H_2O$ before the adoption of the final system. The solid was purchased in 400-lb. wooden barrels which presented some storage problems and were cumbersome to handle. However, this procedure was probably the best way to start machine trials to prove the economies of such a system before adopting the use of aluminum chloride solution.

ALUMINUM CHLORIDE SOLUTION

The specifications for the aluminum chloride solution are given in Table VI. These specifications can be met with either the solid or solution form.

Table VI. Specifications for Aluminum Chloride Solution

$AlCl_3 \cdot 6H_2O$	50% min.
Cl^-	40–44% max.
SO_4^{--}	0.05% max.
Specific gravity	1.283 at 20/20°C.

CONCLUSIONS

The data presented on the results of typical machine production using aluminum chloride in place of papermaker's alum for precipitating the beater size when manufacturing wet-strength papers with melamine resin show that: (1) such a process offers the advantage of producing higher wet-strength papers than can normally be produced in the aluminum sulphate system, (2) appreciable savings can be realized by being able to reduce the melamine resin furnish and still maintain equivalent wet strengths. The use of aluminum chloride in melamine-treated papers is covered by U. S. pat. 2,548,513.

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Specific Heat of Sulphate Black Liquor

R. L. HARVIN and WILSON F. BROWN

The specific heat of sulphate black liquor was measured over the range of concentration from 4.9 to 52.6% solids and temperature from 100 to 200°F. The data were correlated on a graph of specific heat versus solids concentration with temperature as a parameter. An empirical equation was developed relating the three variables and was used to extrapolate the data to higher concentrations and to temperatures beyond those obtainable in the apparatus at atmospheric pressure. Using the concentration-temperature data from a typical black liquor evaporator a simplified empirical relation was found which gives values of specific heat as a function of concentration only, wherein the effect of temperature was included in the value of the constants.

Theoretical considerations in the field of heat transmission and evaporation require the knowledge of certain physical properties of the material under study. Important among these properties are specific heat, thermal conductivity, and viscosity. The present paper deals with specific heat determinations on sulphate black liquor obtained from pulping southern pine at the Hudson Pulp and Paper Corp.'s mill at Palatka, Fla. Future papers will deal with thermal conductivity, viscosity, and correlation of these properties with heat transmission coefficients for sulphate black liquor. For a material such as sulphate liquor the properties must be known as functions of temperature and solids content. It is assumed that the usual sulphate black liquors are sufficiently alike so as to make further characterization unnecessary. It is planned to determine the specific heat of black liquor from several kraft mills in order to test the validity of the assumption. Black liquors obtained from cooking at sustained concentration (*1*) may have specific heat values somewhat different than the ordinary sulphate liquors due to having roughly twice the ratio of inorganic to organic solids.

The literature contains very little information on the specific heat of sulphate liquor. Kobe and Sorenson (*2*) determined the specific heat of sulphate liquor from the pulping of western hemlock. They used liquors of

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Fig. 1. Arrangement of apparatus

four different solids content over the range of 77 to 200°F. The results were correlated as mean specific heat as a function of solids content only, there being no apparent correlation with temperature indicated by their data.

Stevenson (*3*) gives a value for the specific heat of black liquor solids as 0.28. The same reference also gives values of specific heat of black liquor solutions of various solids content. These values are equivalent to the sum of the component parts on a weight fraction basis wherein the specific heat of black liquor solids is 0.50 and water is 1.00. At least one other value for black liquor solids is in common use, namely 0.34.

The literature contains numerous methods of determining the specific heat of liquids, many of which are modifications of the classical methods. The method chosen for this work was similar to that given by Williams (*4*) and was selected because of its simplicity.

This method is based on the measurement of instantaneous rates of heating and cooling during alternate heating and cooling periods of a sample in an insulated vessel. Kobe and Sorenson (*2*) measured the average rates over a 10° interval in a similar apparatus.

The basic equation of calorimetry is, $Q = WC_p\Delta T$, where Q is the heat added to a sample of weight, W, resulting in a change in temperature, ΔT, and where C_p is the heat capacity or the specific heat referred to water at 60°F. Since the heat capacity of water at 60°F. is 1.000 B.t.u. per lb. per °F., the specific heat is numerically equal to heat capacity but has no units. When heat is added to a system which includes a calorimeter vessel a portion of the heat is absorbed by the vessel and some is lost to the surroundings due to the temperature elevation of the apparatus above ambient. The equation becomes

$$Q = [WC_p + (C.E.)]\Delta T + H_L \qquad (1)$$

where $C.E.$ is the calorimeter equivalent and includes all the heat requirements of the system other than the substance under study and H_L is the heat loss. Equation (1) expressed differentially as a function of time becomes

$$\frac{dQ}{d\theta} = [WC_p + (C.E.)]\frac{dT}{d\theta} + \frac{dH_L}{d\theta} \qquad (2)$$

where $dH_L/d\theta$ represents the rate of heat loss to the surroundings, and is dependent on the temperature of the determination. Thus at any temperature level, if the heating is discontinued, $dQ/d\theta = 0$, and $dH_L/d\theta$ may be determined as

$$\frac{dH_L}{d\theta} = -[WC_p + (C.E.)]\frac{dT_o}{d\theta} \qquad (3)$$

where the subscript o designates the no-heat period. Therefore,

$$\frac{dQ}{d\theta} = [WC_p + (C.E.)]\left[\frac{dT}{d\theta} - \frac{dT_o}{d\theta}\right] \qquad (4)$$

wherein $C.E.$ is determined using in the apparatus a material of known specific heat, the rate of heating is determined from accurate electrical measurements during the heating period, and the rate of change of temperature for the heating and cooling periods is determined from the slopes of accurately plotted temperature-time data.

APPARATUS

The apparatus is illustrated in Fig. 1 and is shown diagrammatically in Fig. 2. The sample was contained in a 200-ml. Dewar flask fitted with a cork stopper which was covered with aluminum foil to prevent water absorption. The heating element was a coil of 20-gage Chromel "A" resistance wire. This was contained in a small glass tube bent to form a horizontal circle of $1^1/_2$ in. diameter with the two ends of the tubing extending up into the bottom of the cork stopper. The external copper wire leads extended all the way into the heating coil in the circular portion of the tubing. A glass stirrer was centered just below the heating element and rotated in a glass tube bearing in the cork. A 30-gage copper-constantan thermocouple was held firmly between the cork and the flask and extended into the center of the sample. Sealing wax was used to seal around the heating element and stirrer bearing openings in the aluminum foil. Although it softened during each use it remained in place and formed a vapor-tight seal.

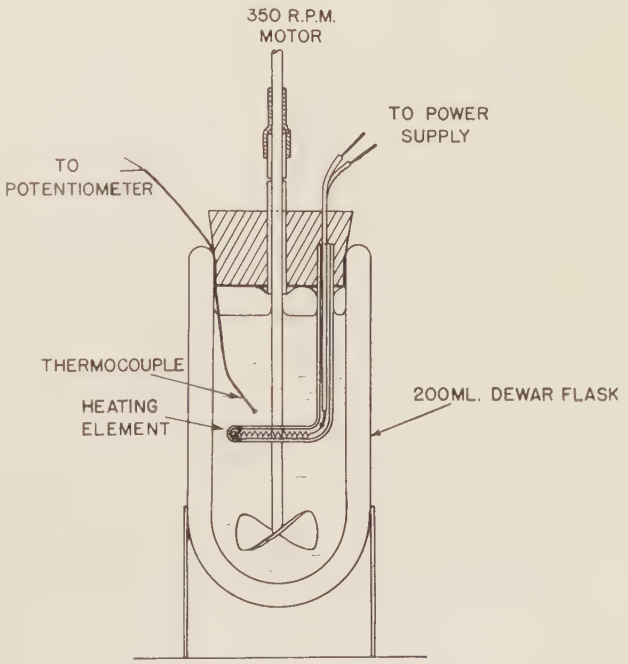

Fig. 2. Cross section of specific heat apparatus

The heating current was supplied by a 6-v. lead storage cell of which usually only two cells were used giving slightly less than 4 v. The voltage was measured by a calibrated General Electric voltmeter accurate to 0.01 v. The current was measured using a General Electric millivoltmeter across a 3-amp., 200-mv. shunt, and was accurate to 0.006 amp. The temperature was measured using a Leeds & Northrup potentiometer, Type 8662, and plots of temperature versus e.m.f. taken from the data in the I.C.T. by Adams (*5*). The temperature measurements were accurate to 0.05°F.

PROCEDURES

The procedure followed in making a test consisted of the following steps:

1. A sample of known solids content was added to the tared flask and accurately weighed.
2. The apparatus was assembled and the heating current was turned on to bring the entire system up to the desired temperature T. The heating current was reduced and a half hour was allowed for the system to attain equilibrium at T.
3. The temperature was allowed to drop to 3 to 4° below T and the heating current was again turned on. Temperature and current measurements were taken at 1-min. intervals until the temperature had passed T by a degree or two.
4. The current was shut off and temperature measurements were again taken at 1-min. intervals until the system was a few degrees below T.
5. Steps 3 and 4 were repeated until consistent results were obtained.

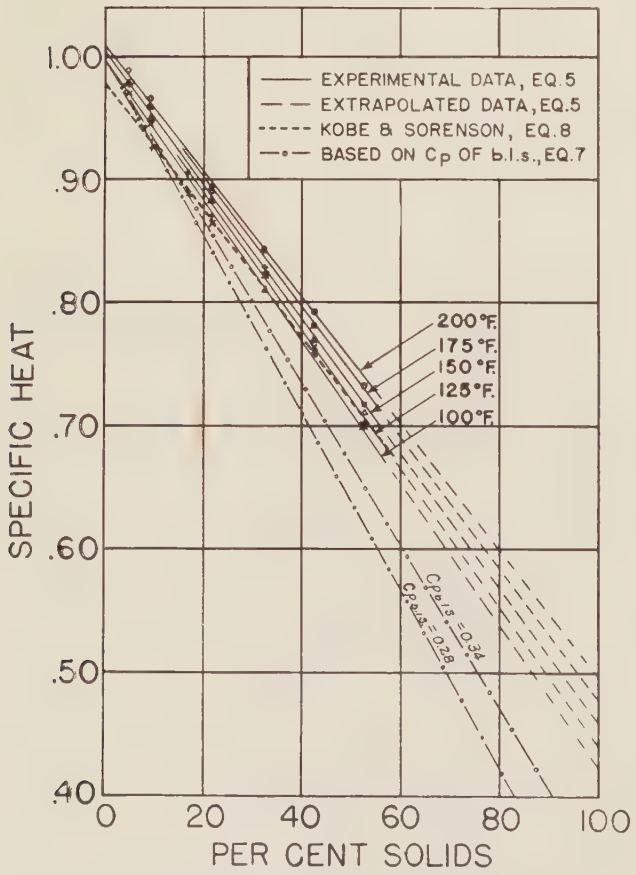

Fig. 3. Plot of specific heat versus per cent solids

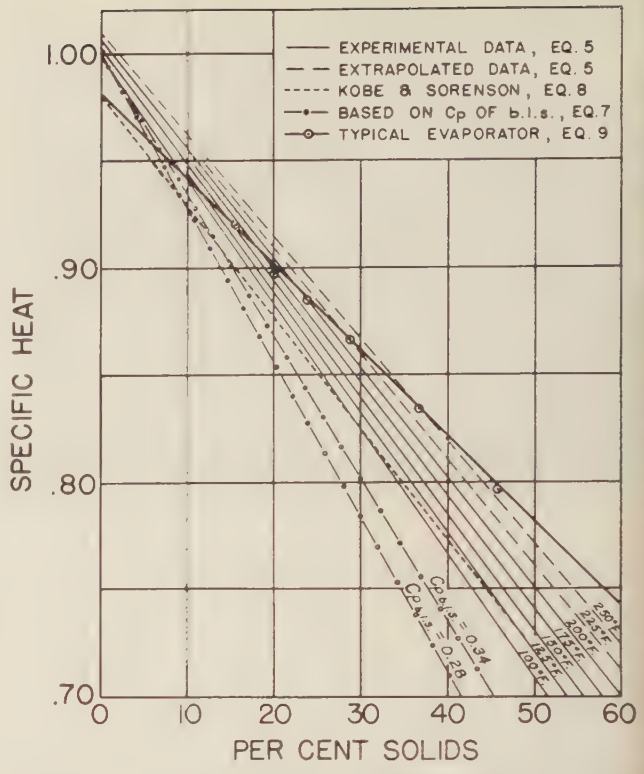

Fig. 4. Plot of specific heat versus per cent solids with correlation for typical evaporator

6. The system was raised to the next higher temperature and steps 2, 3, 4, and 5 were repeated.
7. After the test at the highest temperature had been finished the entire system was reweighed to detect any loss in weight due to evaporation.

A typical calculation for a 270-gram (0.596 lb.) sample containing 52.6% solids at 150°F. is shown as follows:

A. Heating current
Voltage = 3.64
Amperage = 1.534
1 Watt = 0.05692 B.t.u. per min.
$\frac{dQ}{d\theta} = 0.05692EI = (0.05692)(3.64)(1.534) = 0.318$ B.t.u. per min.

B. Rate of heating and cooling at 150°F. from plots of data
$\frac{dT}{d\theta} = 0.444$°F. per min.
$\frac{dT_c}{d\theta} = -0.203$°F. per min.

C. Calorimeter equivalent, $C.E. = 0.0655$ (determined using pure water in the system)

Therefore, by substitution into equation (4),

$$0.318 = (0.596C_p + 0.0655)(0.444 + 0.203)$$
$$C_p = 0.717 \text{ B.t.u. per lb. per °F. at } 150°F.$$

The liquor obtained from the mill came from the last effect of the evaporator and contained 52.6% solids. The various samples were prepared by dilution and were subsequently stored in a refrigerator. The solids content determinations were made by drying at 105°F. a sample which was absorbed on asbestos in a porcelain crucible. In this way no crust was formed and a constant weight was obtained in 24 hr.

The per cent organic matter in the total solids was determined using TAPPI Standard T 625 m-48.

EXPERIMENTAL RESULTS AND DISCUSSION

The experimental results are tabulated in Table I for the range of solids content from 4.9 to 52.6% and for

ble I. Specific Heat of Sulphate Black Liquor at Various Temperatures and Per Cent Solids

ids, %	Temperature, °F. 100	125	150	175	200	Average
4.9	0.971	0.978	0.979	...	0.989	0.979
9.2	0.949	0.926	0.951	0.959	0.965	0.950
8.4	0.889	0.907	...	...	...	0.898
1.6	0.866	0.871	0.883	0.891	0.894	0.881
2.2	0.821	0.829	0.810	0.821	0.843	0.825
2.4	0 764	0.758	0.770	0 781	0.792	0.773
2.6	0.700	0.700	0.712	0.718	0.733	0.713
0.0[a]	0.423	0.441	0.459	0.477	0.495	

[a] Value obtained by extrapolation of data using the equation

$$Cp = 0.990 + 8.0 \times 10^{-5}T - (0.639 - 6.4 \times 10^{-4}T)C$$

peratures from 100 to 200°F. The solids content erminations were found to be very consistent and the ues in the table are averages of several determinaons. The average per cent organic matter in the al solids was found to be 70.8%.

The values of specific heat in the table are averages of determinations. The maximum weight loss due to aporation was on the order of 0.2% of the original ght of the sample and did not affect the results.

The data are shown graphically in Fig. 3 which is a lot of specific heat versus the per cent solids with temrature as a parameter. The specific heat was found increase with increasing temperature and to decrease ith increasing solids content. This is entirely conent with the nature of all the organic and inorganic nstituents of the black liquor and should, in fact, ntinue in similar manner beyond the range of temrature and concentration studied.

An empirical equation was sought to fit the data and late the specific heat, Cp, to both temperature, T°F., nd the solids content as the weight fraction, C. This quation was found to be

$$p = 0.990 + 8.0 \times 10^{-5}T - (0.639 - 6.4 \times 10^{-4}T)C \quad (5)$$

nd is shown as the solid lines in Fig. 3. In dealing ith a series of calculations wherein the temperature nge is not too large or if for simplicity an average lue is desired at a particular temperature level the quation may be simplified. For instance, at 200°F. quation (5) reduces to

$$Cp_{200°F.} = 1.006 - (0.511)C \quad (6)$$

herein Cp is a function of solids content only.

The equation for Cp as a function of T and C has en used to extrapolate the data to the 100% solids is as shown in Fig. 3 by broken lines. These values $Cp_{b.l.s.}$ are tabulated in Table I as a function of temrature.

The method of calculation used in most of the kraft lls consists of assuming a straight line relation beeen pure water with a $Cp = 1.0$ and black liquor ids of an assumed $Cp_{b.l.s.}$ value. This relation is

$$Cp = 1.00 - (1 - Cp_{b.l.s.})C \quad (7)$$

is used irrespective of temperature. As stated ove, Stevenson (*3*) gives two values for $Cp_{b.l.s.}$, mely 0.28 and 0.50. These values are in use in e mills as well as another value of 0.34. Equation 7 plotted in Fig. 3 for the $Cp_{b.l.s.}$ values of 0.28 and 4. The line for $Cp_{b.l.s.}$ of 0.50 falls approximately the 200°F. line of the present data and was left off plot to maintain clarity.

The results of these experiments indicate that at the temperatures used in evaporators (160 to 265°F.) only the value of $Cp_{b.l.s.} = 0.50$, of the ones currently in use, gives nearly accurate results. However, this yields values which are too low at the higher temperatures which are necessary at the higher concentrations.

The error involved in using one of the lower $Cp_{b.l.s.}$ values will naturally increase even more at the higher concentrations.

The data of Kobe and Sorenson are plotted in Fig. 3 using their equation,

$$Cp = 0.98 - 0.52C \quad (8)$$

This single line represents the average of data obtained over the range 77 to 200°F. Their data indicated no correlation with temperature and gave considerably lower values than the 150°F. line which is the approximate average of the present data.

On the basis of the present data the correlation of Kobe and Sorenson gives values much too low for the temperature conditions used in evaporators.

If equation (5), which relates Cp as of function of T and C, can be assumed correct over the range of temperature studied, it may be used with due reservation, to extrapolate the data beyond the range obtainable in the laboratory apparatus at atmospheric pressure. Figure 4 is an enlarged portion of the Cp versus C plot with the lines for 225 and 250°F. drawn as dashed lines. This plot may be used to approximate the Cp values at the temperatures higher than 200°F.

In black liquor evaporators the liquor temperature increases with increasing concentration. This is due partially to the fact that at the higher concentrations the viscosity of the liquor rises rapidly unless temperature is likewise increased. A typical evaporator operation had the following conditions (*3*):

Evaporator effect.	IA	IB	II	III	IV	V	VI
Liquor concentration in feed	45.7	36.7	28.6	23.7	20.0	15.5	15.5
Approximate average temperature of liquor, °F.	265	250	225	200	165	170	160

The specific heat of the liquor in the effects IA, IB, and II where the temperature is above 200°F. may be found by reference to the dashed lines in Fig. 4. The specific heat for the other effects with temperatures 200°F. and below may be found using the solid lines. The above evaporator data, liquor concentration, and temperature are plotted in Fig. 4, and a straight line has been drawn through the points. This line may be considered to be the locus of points representing the actual variation of black liquor concentration, temperature, and specific heat in a typical multiple effect evaporator. The equation for this line is:

$$Cp = 0.98 - 0.40C \quad (9)$$

Thus, the specific heat which is actually a function of temperature and concentration may be approximated as a function of concentration only wherein the effect of temperature is included in the values of the constants.

An equation of this type, based on extrapolated data as it is, necessarily involves some inaccuracies. Nevertheless, it represents a close approximation to the specific heat values in an evaporator of similar operating

characteristics. For evaporators with different concentration-temperature conditions than the example the data may be plotted on Fig. 4 and an equation of the line determined.

CONCLUSIONS

The following conclusions may be drawn:

1. Data are presented which show the specific heat of sulphate black liquor to be a function of solids concentration and temperature.
2. An equation has been developed which represents the data over the entire range studied.
3. The data have been extrapolated beyond the temperature range obtainable in the apparatus used at atmospheric pressure.
4. The extrapolated values have been used to establish a simplified empirical relation between the variations of concentration, temperature, and specific heat actually present in a typical evaporator.

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Explosions in Chlorine Absorption Systems

E. A. MASON, W. C. BAUER, and R. R. QUINCY

During a study of explosions occurring in absorption systems used for the preparation of chlorine bleaching solutions from cell gas, the lower explosive limits for mixtures of hydrogen, chlorine, and air were determined. The presence of explosive mixtures of these gases in the absorption towers was established and traced to the stripping of chlorine from the feed gas. Ignition may have been due to static electricity. The use of an air bleed into the system and of an antifoaming agent in the spray water has been successful in eliminating serious explosions.

The use of chlorine water and hypochlorite solutions as bleaching agents is widespread throughout the pulp and paper industry. Many mills produce the necessary chlorine by the electrolysis of brine. Some of these mills have been plagued by frequent explosions which occur in the equipment used to absorb the chlorine gas in water and in solutions of calcium and sodium hydroxide.

An investigation into the possible causes of these explosions has been carried out. During the course of this work, the lower explosive limits for hydrogen in mixtures of chlorine and air were determined. Recommendations were made which have led to the elimination of such explosions.

A diagram of a typical absorption system as employed in one pulp mill is shown in Fig. 1. Chlorine gas from diaphragm-type electrolytic cells is introduced into the first tower where it is scrubbed with water in the packed section and then passes downward through the unpacked section into the second tower and then into the third tower. In the last two towers the gas is further scrubbed with a suspension of milk of lime which is introduced through sprays at the top of each tower. The chlorine water from the bottom of the first tower flows directly into a storage tank, but the liquid effluent from the last two towers is recirculated through the towers until the bleach is of the desired strength. The clear solution is then pumped to a storage tank, and fresh milk of lime is circulated in the towers. In this mill caustic soda is also used in preparing bleach. The entire system is kept under a slight vacuum which is maintained by a pump discharging the unabsorbed gases to the atmosphere. The vacuum is controlled by bleeding air in after the third tower.

Prior to the beginning of this investigation, explosions occurred in these towers and in the lines connecting them at an average of about one or two a month when the chlorine water tower was in operation, although as many as two and three explosions took place during a single day. Some of these explosions were characterized by a surge of pressure in the equipment which lifted the manhole covers at the tops of the towers and blew out the water seals. At other times, the manhole covers were blown to the ceiling, a distance of some 10 ft. On rare occasions the force generated was sufficient to crack the concrete towers seriously. Another mill which has three towers for the production of chlorine water has had explosions of a similar nature.

At the start of this investigation, several possible causes of these explosions were examined. It was suggested that chlorine-hydrate, if present in the system, might generate sufficient gas upon decomposition to cause an explosion. Another thought was that foam was plugging the towers and leading to a pressure build-up. Upon considering the properties of the materials and the system involved, however, these two possibilities were ruled out as likely causes.

A third theory for the cause of the explosions is that explosive gas mixtures may exist at certain times in the absorption systems. Since the anode gas from most types of diaphragm cells contains some hydrogen as well as oxygen, the latter resulting from certain anode reactions as well as air leakage, the presence of explosive mixtures was not unlikely. Data are available for the lower explosive limits of hydrogen-chlorine (*10*) and hydrogen-air (*4, 5, 11*) mixtures alone, but none were found for mixtures of hydrogen, chlorine, and air which

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were considered applicable to the system under consideration. Laboratory experiments were therefore carried out to determine the lower explosive limits of mixtures of hydrogen, chlorine, and air. In addition,

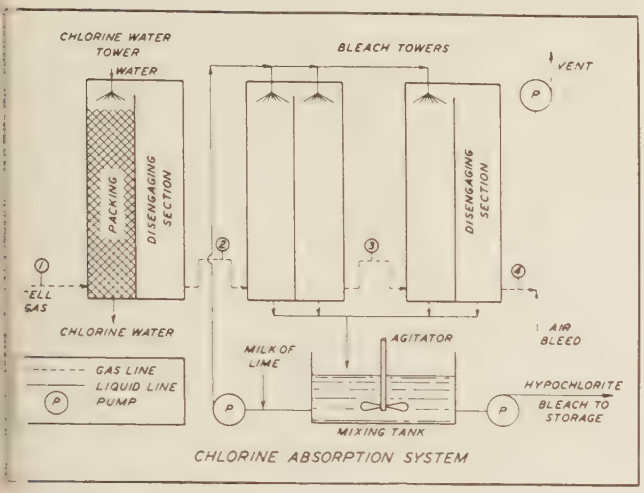

Fig. 1. Chlorine absorption system

samples of gas at various points in the absorption system (indicated by the circled numbers in Fig. 1) were withdrawn and analyzed to determine whether they were in the explosive region.

EQUIPMENT AND PROCEDURE

Laboratory Equipment

Two different types of apparatus for determining the lower limits of explosion were used. Apparatus A is shown diagrammatically in Fig. 2. The explosion chamber consisted of a 1-liter suction flask fitted with a rubber stopper to hold the two electrodes and a stirrer for mixing the gases. The volume of gas contained in the flask was approximately 1160 cc. The sparking mechanism consisted of a Ford induction coil, a variable resistor, a 6-v. transformer connected to the 110-v. line, a switch for closing the circuit, and a spark gap of 1/4 in. The three gases were introduced through stopcocks in the manifold connected to the flask. A mercury manometer was used to measure the pressure in the system as the various gases were admitted to the system. An aspirator served to reduce the pressure before the hydrogen and chlorine were admitted.

The sparking mechanism of apparatus B was essentially the same as that in apparatus A, but the explosion chamber consisted of a vertical glass cylinder 5 cm. in diameter and 35 cm. long. The apparatus was at first provided with a spark gap at the center of the chamber only but was later modified to allow for ignition at either 5 cm. from the bottom or 5 cm. from the top of the chamber. In addition, a U-manometer containing water was attached to the explosion chamber and was used to indicate the presence of a pressure rise following the spark discharge. Mixing in this apparatus was accomplished by means of a mixing chamber to which was connected a large leveling bottle holding concentrated sulphuric acid as a confining liquid. The gases, after metering, were forced back and forth between the explosion cylinder and the mixing chamber. Since the concentrated sulphuric acid would have a dehydrating effect upon the gases, they were passed through drying tubes containing calcium chloride which were installed in the gas lines.

All parts of both apparatus which contained hydrogen and chlorine at any time were painted black in order to prevent the photochemical reaction of hydrogen and chlorine.

Gases

The hydrogen used was generated by contacting zinc and hydrochloric acid. Air was admitted from the room. In the runs using apparatus A, the chlorine was admitted from a laboratory cylinder, and with apparatus B chlorine was prepared by the reaction of hydrochloric acid and potassium permanganate. This chlorine was scrubbed in a wash bottle to remove hydrogen chloride and then stored in a bottle by displacement of water; the gas was withdrawn as needed. Both the hydrogen and the chlorine passed through the drying tubes in apparatus B. The effect of any hydrogen chloride that might have entered in spite of the precuations was considered to be negligible in view of the work of Kunin and Serdyukov (*7*) on explosive limits of hydrogen-chlorine mixtures in the presence of hydrogen chloride.

Procedure

The explosion vessel, containing only air, was partially evacuated and a reading of the mercury manometer made. Hydrogen was then admitted and the pressure read. Chlorine, if used, was admitted and a reading made. The system was brought to atmospheric pressure by the addition of air, and the gases were mixed. The electrical circuit was then closed causing a spark in the explosion chamber. In apparatus A, the explosion vessel contained a few milliliters of water while apparatus B was kept dry. The composition of the gas mixture was determined from the barometric pressure and the readings of the mercury manometer. The mixture was judged to have exploded if one spark caused a pressure rise in the system, as noted on the manometer, or blew the stopper from the top of the apparatus. If repeated sparks were required to bring

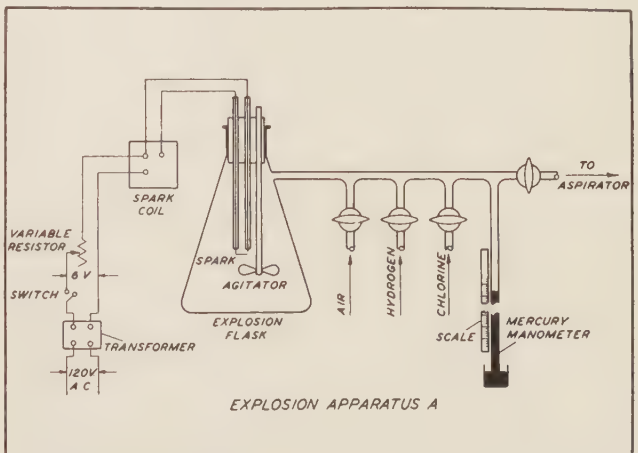

Fig. 2. Explosion apparatus A

about ignition, the mixture was judged to be below the lower explosive limits; it was assumed that the repeated sparks were causing local heating which finally led to the ignition.

Table I. Lower Explosion Limits of Chlorine-Hydrogen-Air

Total Pressure = 30.0 to 30.3 in. mercury; Temperature = 22 to 26°C.

Apparatus	Ignition	Volume % Chlorine	Volume % Hydrogen	Volume % Air	Water content	Explosion
A	Center	...	5.1	94.9	Wet	No
	Center	...	6.4	93.6	Wet	Yes
B	Center	...	4.1	95.9	Dry	No
	Center	...	4.5	95.5	Dry	Yes
B	Upward	...	4.0	96.0	Dry	No
	Upward	...	4.2	95.8	Dry	Yes
B	Downward	...	5.1	94.9	Dry	No
A	Center	33.8	5.2	61.0	Wet	No
	Center	32.6	6.4	61.0	Wet	Yes
A	Center	49.4	5.2	45.4	Wet	No
	Center	48.0	6.6	45.4	Wet	Yes
B	Upward	68.5	4.1	27.4	Dry	No
	Upward	68.3	4.3	27.4	Dry	Yes
B	Upward	87.8	4.5	7.7	Dry	No
	Upward	87.3	4.9	7.7	Dry	Yes
B	Downward	86.2	6.1	7.7	Dry	No

Samples were withdrawn from the plant absorption system at points 1, 2, and 4 indicated on Fig. 1 and analyzed for chlorine, carbon dioxide, oxygen, hydrogen, and inerts by Orsat techniques. Concentrated sulphuric acid was employed as a confining fluid. Samples were also drawn into explosion apparatus A from points 1, 2, and 3 on Fig. 1 to determine whether they would explode.

RESULTS AND DISCUSSION

Lower Explosive Limits

The results of the laboratory experiments on the lower explosive limits of mixtures of hydrogen, chlorine, and air are presented in Table I. While many samples ranging from well below the explosive range up to about 11% hydrogen were tested, only the composition of the two samples between which the explosive limits fell is given in Table I. The arithmetic averages of these two values were taken to give the points plotted in Fig. 3; values reported by other investigators are also shown.

In dealing with the study of explosive limits certain definitions and criteria must be established. The term explosive limits, or limits of inflammability, means the limiting compositions within which a flame will propagate through the entire volume of a mixture. This is usually accompanied by an increase in pressure. Jones (*5*) and Jost (*6*) point out that the explosive limits for any mixture are somewhat dependent upon the apparatus and techniques employed. The limits of inflammability in this work were those determined under such circumstances that ignition occurred extremely easily; ignition is used to designate propagation throughout the entire gas mixture. These standards were proposed by Jost (*6*). In general, it has been noticed that ignition will propagate more readily in an upward than in a downward direction because of convection. The values reported in Table I are for upward propagation and hence allow a factor of safety in their application to the prevention of industrial explosions. Jones (*5*) states that limits of explosion obtained in cylinders are independent of the size of the vessel for diameters greater than 2 in.; both pieces of apparatus used in this work are larger than this. Jost (*6*) has pointed out that the nature of the spark discharge can have an effect upon the explosive limits. Following his suggestion, a strong spark and care in distinguishing between local ignition and actual propagation were employed.

All of the work of this investigation was carried out at atmospheric pressure and room temperature. Jones (*5*) and Jost (*6*) have pointed out that ordinary variations in laboratory temperature and atmospheric pressure have no appreciable effect upon the limits of inflammability. The presence or absence of normal quantities of water vapor at room temperatures has only a very slight effect upon the lower limits (*4, 5*).

The difference in the lower limit for mixtures of hydrogen and air as determined by center and bottom ignition in apparatus B is hardly detectable. It was concluded that center ignition in apparatus B could also be considered as upward ignition. The explosive limit for hydrogen and air in apparatus A appears to be about 1% of hydrogen higher than that found in apparatus B. This may be due to the different shapes of the vessels. The lower limits of explosion were not determined for downward propagation in this study; the values listed in Table I are for the mixtures studied which contained the largest amounts of hydrogen.

The values in Table I for hydrogen-air mixtures under upward propagation are in excellent agreement with those of other workers (*4, 5, 10*). While ignition of mixtures of hydrogen and chlorine was not attempted in this work, Weissweiler (*10*) using a metal bomb and center ignition found that approximately 4% hydrogen in chlorine marked the lower limit. Lindeijer (*8*) made a study of the explosion limits of hydrogen-chlorine-oxygen mixtures in a glass tube 30 cm. long and 1.5 cm. inside diameter which was equipped for downward propagation. The results were similar to those of this study in that the lower limit was principally fixed by the hydrogen content of the gases although the values reported by Lindeijer ranged from 10.4% hydrogen in mixtures high in chlorine to 7.9% for mixtures containing little chlorine. Judging from the data on hydrogen-air and hydrogen-oxygen mixtures (*4*), it is likely that the differences existing between the limits found in this study and those of Lindeijer are primarily due to differences in the size of apparatus and direction of propagation.

It is interesting to notice that the lower explosive limits for mixtures of hydrogen-chlorine-air are determined almost completely by the concentration of hydrogen present. The effect of chlorine or air on this lower explosive limit seems to be the same, so that mixtures of these gases containing more than about 5% hydrogen are above the lower explosive limit regardless of the relative proportions of chlorine and air.

The amount of violence and pressure produced upon explosion varied with the gas composition. Roughly speaking, once the hydrogen content of the gases tested had reached the 10% level, for mixtures containing from 0 to 60% chlorine, the explosions produced were quite violent in nature always blowing the stoppers out of the top of the apparatus and causing a sharp report. Below this level, the explosions merely caused a pressure reading or blew the water from the manometer and made a less sharp noise. While no attempt was made to distinguish between the intensity

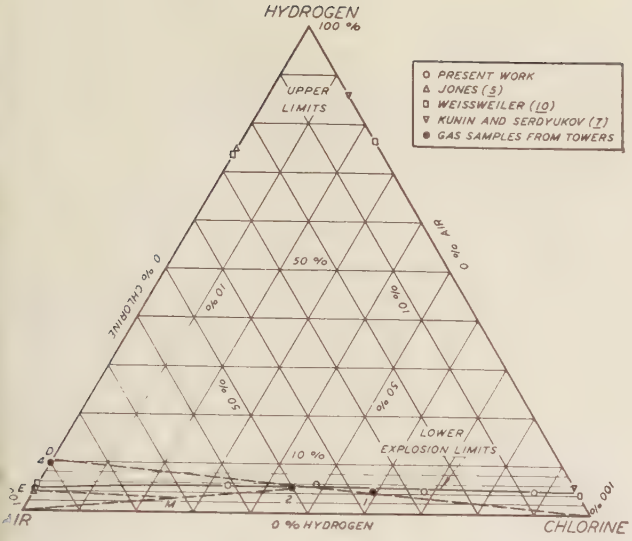

Fig. 3. Explosive limits for hydrogen-chlorine-air mixtures

of explosions, these qualitative variations in character are in general agreement with the nature of the various explosions in the chlorine absorption system.

Gas Samples from Absorption System

Analyses of gas taken from sample points 1, 2, and 4 (see Fig. 1) are plotted in Fig. 3. All components other than hydrogen and chlorine are classified as air. The lower explosive limits determined in the laboratory are valuable in understanding how explosions can take place in the absorption system. It can be seen that only the gas from point 4 is in the explosive range. Samples of gas from points 1 and 2 did not explode in the laboratory apparatus. While an analysis of the gas from point 3 was not made, a sample of it did explode in the laboratory apparatus A. The composition at this point would be expected to lie between those of point 2 and point 4 indicated on Fig. 3 and hence would presumably be above the lower explosive limit. Furthermore, after a sample of gas from point 2 was bubbled through caustic to absorb chlorine, an explosion was produced in the laboratory apparatus. These facts indicate that explosive mixtures can exist in the towers due to the absorption of chlorine.

A straight line on Fig. 3 connecting the analysis at the inlet to the chlorine water tower, point 1, and the 100% chlorine apex traces the path that should be followed in the absorption towers due to the stripping of chlorine. Complete removal of chlorine would result in a gas having the composition shown at D. The fact that the analyses from points 2 and 4 lie slightly below this line probably indicates the presence of small air leaks in the system. It should be pointed out that the samples represented on Fig. 3 were taken at approximately the same time. Sampling at other times has shown that the composition of the feed gas and of the gas at the other points can vary considerably. This is probably due to changes in the operating conditions of the system or to changes in the electrolytic cells. It is evident that if a source of ignition is present, explosions are likely to occur.

It is interesting to note that if the feed gas to the chlorine-water tower has 60% chlorine and less than 35% hydrogen the composition of the gases will not fall in the explosive range at any point in the absorption system.

Ignition Source

With the fact established that explosive mixtures can easily be present in chlorine absorption systems, consideration must be given to the action which would initiate the explosion. Here the picture is not as clear. Several possibilities were considered. Because there was no relationship in time between the explosions in the absorption towers and occasional explosions of individual electrolytic cells, it was felt unlikely that the initiating source was in the cells. Furthermore even with the most violent of the explosions in the towers, none of the packing was blown from the chlorine absorption tower and only a few packing rings at the top were broken. . The action of sunlight upon hydrogen-chlorine mixtures as an initiating source was deemed unlikely, because the towers and connecting lines are so constructed that there is little chance for direct sunlight to reach the gas stream; nevertheless cases may certainly exist where such a condition is present.

In reviewing the history of the explosions, it was found that, with possibly one exception, they have occurred only when the chlorine water tower was being used. Until this first tower was used for the production of chlorine water and during a subsequent period when chlorine water was not produced, no explosions took place. Shortly after operations were resumed, the explosions began to occur again. When chlorine water is not being made, nothing is changed in the operation of the cells, and it is to be presumed that explosive mixtures could exist in the bleach towers due to the absorption of chlorine. In another mill where chlorine water is prepared in spray towers and the calcium bleach is prepared in mixing boxes, violent explosions have taken place but only in the chlorine water towers. This has led to the conclusion that the source of ignition is connected with the production of chlorine water.

In general, the principal difference in operation between chlorine water towers and alkali bleach towers is in the liquid which is sprayed in at the top. Reference (*1, 2, 3*) has been made to the generation of electrical charges which are built up when water droplets move through air and by the disruption of the liquid interface during the formation of droplets or bubbles, although these charges have generally been relatively small. Abramson (*1*) points out that certain metallic and organic compounds, such as the higher alcohols, have a repressing effect on the electrical charges generated by the disruption of liquid interfaces. It is therefore possible that static charges may be built up through spraying or foam formation in the towers. If the formation and movement of the droplets and foam in the absorption system cause electric charges of sufficient intensity to cause sparking, such charges may be present only in the chlorine water tower due to a repressing effect of the sodium and calcium ions in the alkali bleach. This would explain the fact that explosions only occur when chlorine water is being produced.

Two holes were drilled in the top of the chlorine water tower and a probe connected to a gold-leaf electroscope was inserted through these holes. This

procedure did not indicate the presence of static charges; however, the apparatus was quite crude and most of the tower was inaccessible. While it can only be said that static electricity appears to be a plausible and likely source of ignition, it is evident that explosive mixtures of gas can, and do, exist within the absorption system and presumably have led to the violent explosions which have taken place.

Although the presence of explosive mixtures was not detected in any of the samples taken from the chlorine-water tower, it is believed that occasionally such mixtures can exist there and are subject to ignition. Factors which would lead to the presence of explosive mixtures in the first tower are those which would cause an increase in the stripping of the gas or an increase in the hydrogen content of the feed. A decrease in the temperature of the water fed to the chlorine tower, a failure or surge of the vacuum pump, and punctures of the diaphragms on the electrolytic cell are examples. The ignition of an explosive mixture at the top of the first tower could propagate to the bleach towers where the hydrogen content would be even higher.

Prevention of Industrial Explosions

With these findings as a basis several recommendations can be made with regard to the prevention of explosions in such absorption systems. An obvious preventive measure is, of course, that the amount of hydrogen contaminating the anode gases be reduced to a point where no hazard would exist in the absorption system. For most cell gases, this safe limit would be somewhat less than 2% hydrogen. If, however, this is impractical or impossible, there are two possible safety measures which would then apply. The first is to bleed sufficient air into the system to keep the hydrogen content of the gas below the lower explosive limit. The amount of air required and the most desirable point for its introduction into the gas stream depend upon accurate gas analyses and a consideration of the data for the explosive limits of hydrogen-chlorine-air mixtures presented in Table I. Providing that the hydrogen content of the feed gas is not high the desirable point for the air bleed would be at the top of the chlorine water tower. In this way gas entering the chlorine water tower would not be diluted, and control of the concentration of the chlorine water produced would not be affected. Generally, the bleach towers are large enough so that the absorption of chlorine in them is practically complete and the introduction of an air bleed would not greatly increase the chlorine losses from the system.

The effect of such an air bleed is shown on Fig. 3 where the analysis at point 2 is used as an indication of the composition at the top of the chlorine water tower before the air bleed. If air were bled into the mixture at point 2 until the composition of the gases reached point M, complete absorption of the remaining chlorine would still leave the gases below the lower explosive limits at point E. In the system shown in Fig. 1, it was predicted that a 1.75-in. hole would protect that system from explosions. Since the introduction of this air bleed, no explosions have occurred. The amount of inerts being vented to the atmosphere has been roughly doubled, but tests indicate that the chlorine losses in this stream are still less than 20 lb. per day.

The maximum limits of explosion for the systems, hydrogen-air and hydrogen-chlorine, as determined by other investigators have been indicated on Fig. 3. It is unlikely that the maximum explosive limits could be utilized in preventing explosions in the manufacture of bleaching solutions from normal cell gas.

A second recommendation, which is based upon the assumption that an electrostatic discharge in the chlorine water tower is responsible for ignition of explosive gas, is to add a small amount of defoamer to the water feed to this tower. In one mill where serious explosions have occurred in the past, a relatively small amount of antifoaming agent is now pumped into the water line. Since this has been done, only a few pressure surges have been noticed in the system. Whether this defoamer has been effective by decreasing static charges that may be generated on the sprays or at the foam is not known. The use of defoamer has not eliminated all pressure surges. Furthermore, explosive mixtures of gases in the towers could be ignited by any stray source that might be present. It is therefore recommended that an antifoaming agent be used in preventing explosions only in conjunction with an air bleed.

The defoamer which has been used is one also used in paper mills. No effect of the small amount of defoaming agent used has been noticed on the bleaching properties of the chlorine water.

SUMMARY

The lower limits of inflammability for mixtures of hydrogen-chlorine-air have been determined experimentally and should be useful to others in preventing explosions in systems which deal with mixtures of these gases. Two recommendations for the avoidance of industrial explosions in chlorine absorption systems where explosive mixtures may be present are: (1) addition of an antifoaming agent to the water feed of the chlorine water tower, and (2) air dilution of the gas stream to keep the mixture below the lower explosive limit. The use of a combination of these two techniques would seem a wise policy in mills troubled by explosions.

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Rules for Proper Steam Blast Coil Installation

RICHARD G. LUBINSKY

Most troubles encountered with steam coils on industrial applications can be traced back to improper installation. In just about every instance, the faulty installation violates long established rules—rules that have been formulated only after field experience. Many operating engineers do not realize the seriousness of these errors only because they have not given thorough consideration to fundamentals. A detailed study of what happens in the system when each of the errors is encountered will readily explain why they must be avoided. It may cost slightly more to make a carefully engineered installation following all the rules of good installation practice but it will prove economical in the long run. The cost of making repairs and of lost production during shutdowns can be tremendous. This paper outlines the common causes of trouble, explaining why coils fail under various conditions and establishes rules to be followed to realize long, satisfactory, and economical service from heat transfer surface.

HAVE you been plagued with early steam blast coil failures in your plant? If you have been using equipment of a reputable manufacturer and have been having such troubles, it's more than likely that your difficulties are due to improper installation. This is highly important to the pulp and paper industry because a tremendous number of coils are used in its processes.

Over a period of years heating engineers have evolved a set of rules for steam blast coil installation which cannot be violated if trouble-free service is to be expected. These rules have been established not from theory or because some engineer has dreamed up a possibility of trouble occurring, but from actual experiences on field installations.

At times the initial cost of installing a bank of steam blast coils following the recommendations established by experience, may be somewhat higher, but it takes only one failure to make this additional cost look insignificant. Coil failure not only represents an expense in replacement or repair of the unit itself, but the cost of removing and re-installing as well as the loss of production during the shutdown period can be enormous. If the time is taken to analyze the causes of coil troubles, it will readily be understood that the little precautions that can be taken to prevent early failure will be amply rewarded.

There are two fundamental rules for the proper operation of a steam system both from the standpoint of proper capacity and length of service. If these rules are followed, the problems will be minimized. Here are those two all-important rules: (1) air must be thoroughly vented from the heating surface, and (2) condensate must drain freely into the return system.

Any system on which these two fundamentals are not achieved will be troublesome because the capacity of the heat transfer equipment will be decreased and early failure may be expected from any one of four different sources: (1) corrosion, (2) rupture due to a difference in expansion of tubes, (3) breakage due to excessive pressures from water hammer, and (4) rupture due to freezing.

Air in a system will prevent steam from reaching the condensing surfaces, lowering the heat transfer capacity. The presence of air in a system is one of the first things to look for when coils do not heat properly. Noncondensible gases such as free oxygen and carbon dioxide can cause rapid corrosion if not eliminated from the system.

One of the greatest causes of excessive corrosion in heat transfer surface is the presence of condensate standing within the tubes as shown in Fig. 1. A number of cases have been observed where, because of improper drainage, the tubes of coils have corroded through right at the surface of the condensate that was standing in them. In the case of coils with vertical tubes, tubes have been cut off at a point that looked as if it had been turned in a lathe. Metallurgical experts on corrosion say that the presence of condensate and noncondensible gases such as carbon dioxide permits the gas to unite with the condensate forming highly corrosive acids.

When coils are installed with horizontal tubes like those shown in Fig. 2, improper drainage can cause the lower tubes to fill with condensate. The water-logged tubes do not expand by the same amount as the tubes filled with steam setting up stresses that may eventually cause the tubes to rupture.

If condensate is allowed to collect in any part of the piping system or coil due to improper pitch, the steam pressure behind this slug of liquid can pick it up and drive it down through the system at tremendous velocities which can rupture tubes, break headers, and ruin traps.

COMMON MISTAKES

Improper Pitch. In Fig. 3 the installation crew thought the coils were absolutely level. However, due to a slight amount of settling of the coil foundation the coils are pitched down slightly to the supply end. Notice how the steam, flowing in the opposite direction in which the condensate is trying to flow, has a tendency to cause ripples in the condensate. When there is sufficient condensate to cause these ripples to close up the tube, a slug of the condensate is driven down through the tube with terrific force; force which has been known to crack headers, break tube to header joints, and even rupture tubes. This same thing can happen if the supply piping to the coil is not properly pitched and trapped.

Avoid Modulating Controls with Overhead Return. A coil controlled by a modulating value with a bucket trap and overhead return line is shown in Fig. 4. This

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installation will function properly as long as the valve is open, but as soon as the steam supply is modulated down to a low pressure, the force necessary to push the condensate up into the return line no longer exists at this point and as a result condensate backs up into the coil.

Visualize what happens when the trap is too small to handle the condensate being formed. Condensate accumulates in the coil until the coil capacity is reduced to the point where the amount of condensate formed is equal to the trap capacity. Condensate can stand within the coil resulting in any one of the failures that can be attributed to such a condition.

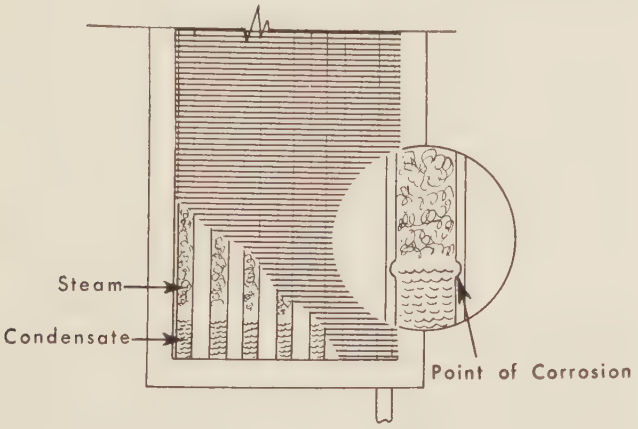

Fig. 1. Condensate standing in coil with vertical tubes can result in corrosion failure

Trap Each Coil Separately. Much has been said about the use of a single trap on a bank of coils. Figure 5 shows such an installation. The coils are arranged for series air flow and one can readily see that the pressure drop on the steam side in the first coil in direction of air flow is much greater than it is in the last. The entering air temperature into the first coil is lower and as a result the coil condensing capacity is greater. The first coil in the direction of air flow may condense 1000 lb. of condensate while the last coil will condense only 200 lb. of condensate each hour. With steam being supplied at 100 lb. pressure, the pressure drop in the first coil may be as much as 5 lb. In the last coil, because of the small flow, it may be negligible.

The pressure in the return piping at the head of the trap will be very close to 100 lb. and one can easily see that the steam will flow from this return system into the first coil in the direction of air flow. This steam flowing in will have a tendency to hold condensate in the coil, reducing capacity and endangering coil life.

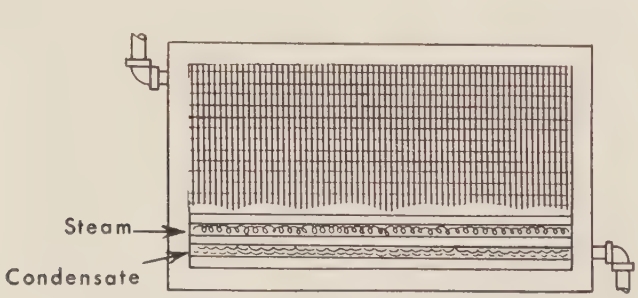

Fig. 2. Condensate standing in coil with horizontal tubes causes unequal tube expansion

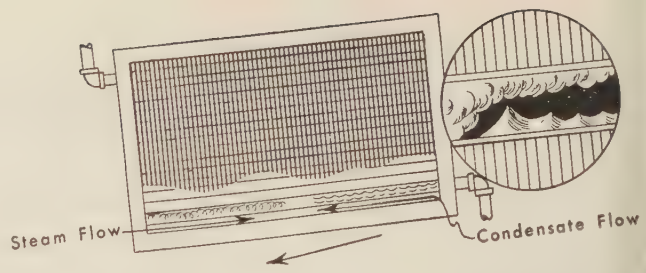

Fig. 3. Reverse pitch invites water hammer

One Trap May Be Sufficient on Parallel Air Flow. Coils arranged for parallel air flow, such as shown in Fig. 6, may give satisfactory results when connected to a single trap if the air velocity over each of the coils is uniform. Many installations have been made in this fashion with acceptable results. However, when coils are arranged for series air flow, it is extremely important that an individual trap be used on each of the coils.

Poor System Design Can Cause Coil Failure. Poorly designed supply and return systems are often the cause of early coil failure. Figure 7 shows supply piping bullheaded into the coil in such a way that all of the expansion in this long steam main must be absorbed by the coil. No coil can stand these expansion stresses. When the condensate from a long run of steam main is permitted to drain through a coil such as seen in this line, there is a good possibility that damage due to water hammering may result.

Condensate must not be allowed to collect ahead of valves as shown in Fig. 8. Even though the valve is opened very slowly, there is still a possibility that a slug of condensate will be driven down into the blast heating coil causing failure of the coil and perhaps even the trap.

All of these troubles are easily explained and can be avoided by taking proper precautions. It is surprising

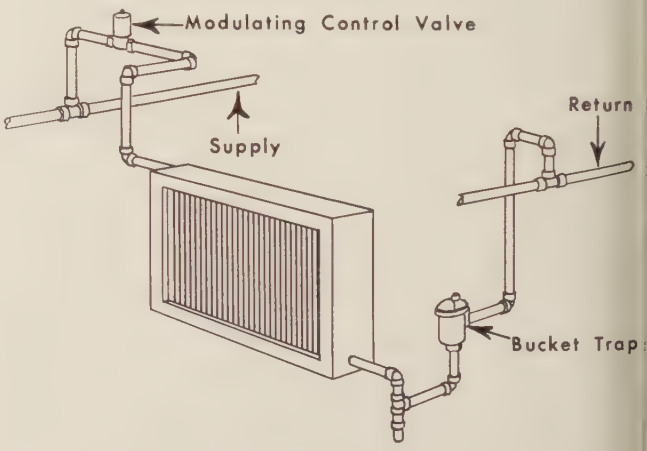

Fig. 4. Never use overhead return with modulating control

how many installations are made that violate the rules of good installation practice.

EQUIPMENT

The negative side—what not to do—has been reviewed; now consider that which must be done to obtain maximum service from heat transfer equipment.

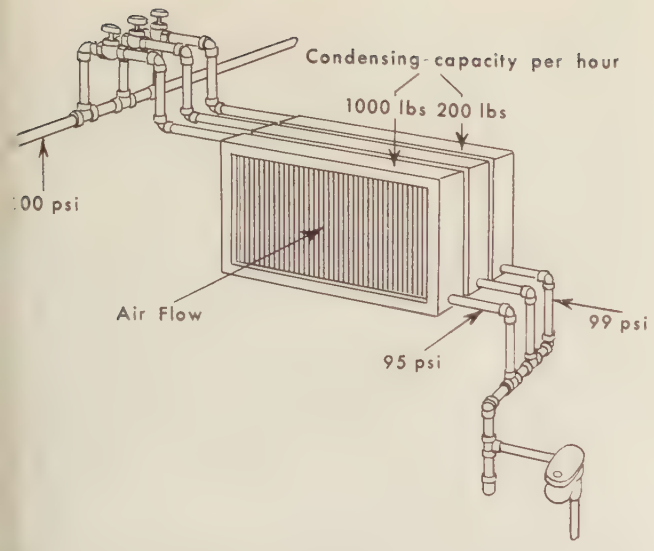

Fig. 5. Coils arranged for series air flow on one trap invite trouble

Coils

In making a satisfactory coil installation, one must make a number of decisions.

First, one must select the proper coil to meet the conditions of the installation and operation. There are three distinctly different types of coils, each of which has definite advantages for various types of installations.

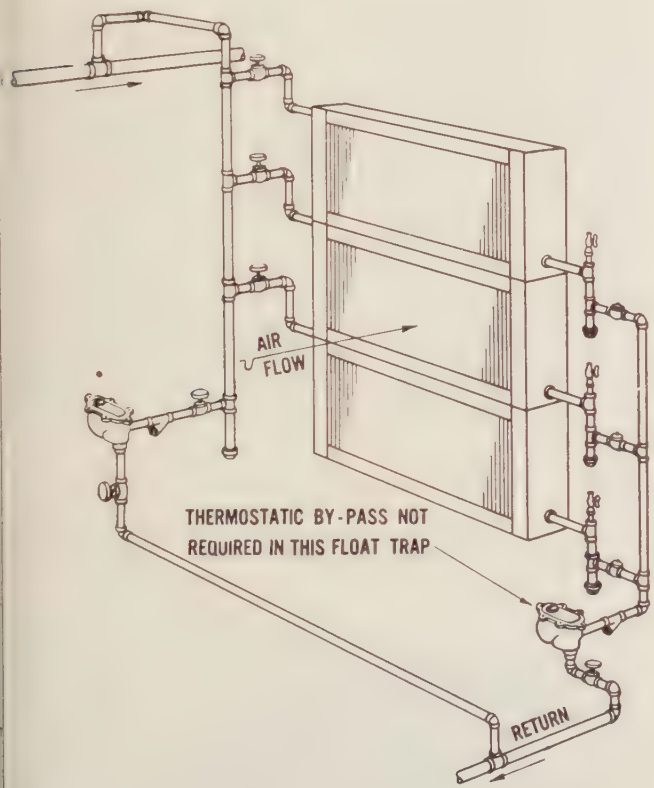

Fig. 6. Coils in parallel on one trap may operate satisfactorily

There is the coil with a single condensing tube having headers at opposite ends, as illustrated in Fig. 9.

There is the coil having a tube within a tube arrangement to provide uniform temperature distribution and decrease the danger of freezing under modulated conditions. This general type is available in two designs. One has connections at opposite ends and is shown in Fig. 10. Note that the steam enters at one end and condensate drains from the opposite end. The other has connections at the same end as shown in Fig. 11. Steam flows into the distributing tubes from the supply compartment of the

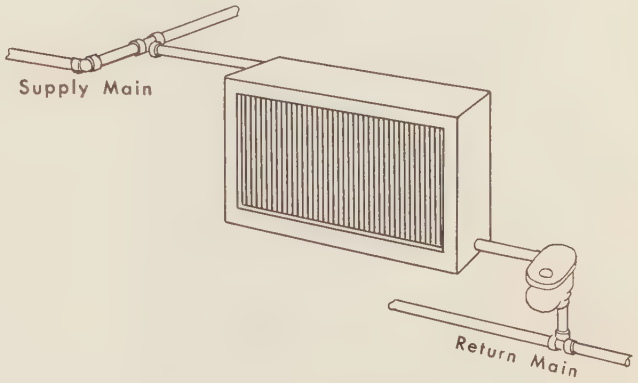

Fig. 7. Piping without proper swing joints is dangerous

header out into the condensing tubes through kinetic orifices where it is condensed. The condensate flows from the condensing tubes into the return section of the header and then out into the return system.

The third type of coil, as illustrated in Fig. 12, is one of all-welded construction having heavy wall tubes and arranged so that the coil expands away from the headers, eliminating any possibility of stresses on the tubes due to external piping or to the expansion of the tubing itself.

Coils with single condensing tubes are the type in most common use. They are the lowest priced of the three types and are satisfactory for use on systems where the steam pressure does not exceed 200 p.s.i. Coils of this type will give satisfactory operation as long as the steam supply will not be modulated beyond that ordinarily required to fill the coil, or if the stratification of leaving air temperature is unimportant and the danger

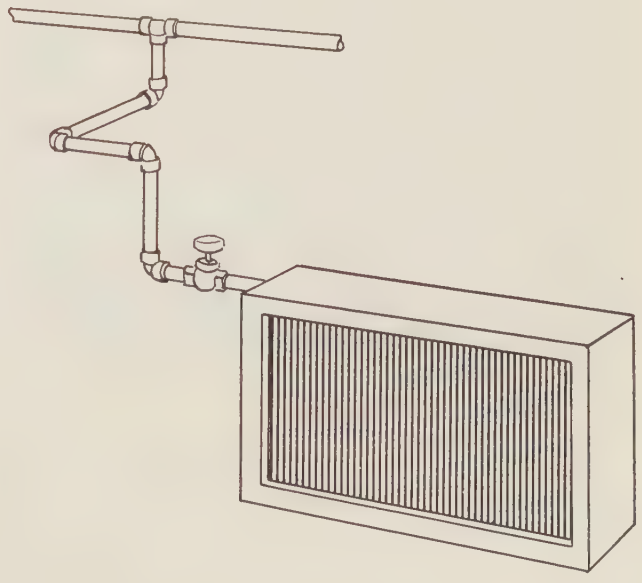

Fig. 8. Do not permit condensate to collect ahead of valves

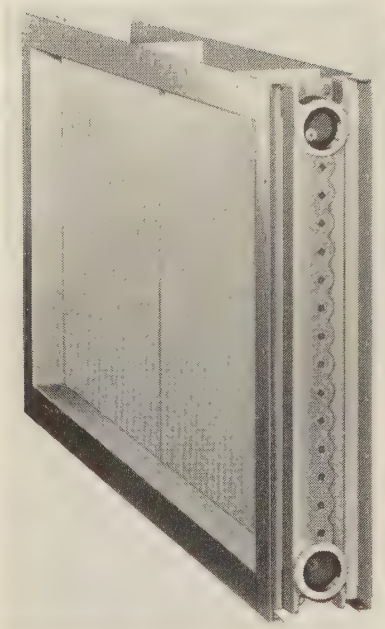

Fig. 9. Type E steam coil without steam distributing tubes

of freezing does not exist. It is a sturdy coil backed by years of satisfactory service.

The coils with steam distributing tubes should be used whenever the supply of steam will be modulated beyond that ordinarily required to fill a single tube coil, and the danger of freezing exists or nonstratifying performance is desired. Steam distributing coils will distribute the steam over the length of the coil giving fairly uniform air temperatures, and the coils are designed not to freeze even though the entering air is well below 32°.

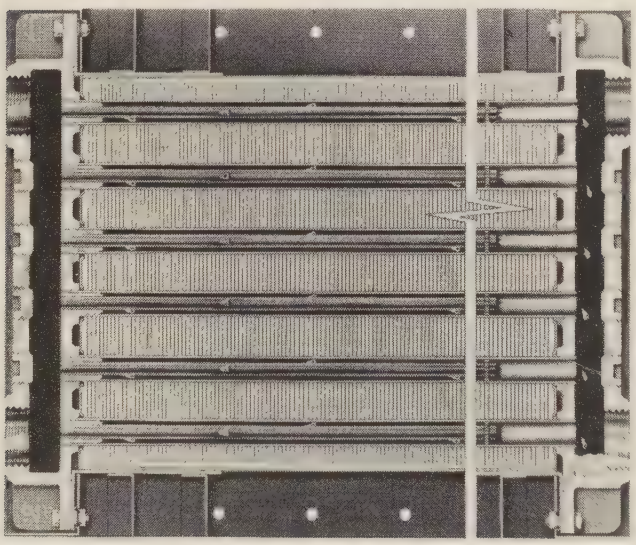

Fig. 10. Type SDO coil with steam distributing tubes

The welded header coil is reserved for particularly severe conditions where steam is turned on and off at frequent intervals. The free expansion of the tubing and the heavier wall can be expected to give somewhat longer life than a coil having headers at opposite ends. Coils of this type must be used whenever steam pressure will exceed 200 p.s.i.

Traps

The selection of the proper trap is important. On steam blast coils, float and thermostatic traps, as shown in Fig. 13, give the best service except where return lines are run overhead. Under these conditions, bucket traps properly installed must be used. Float and

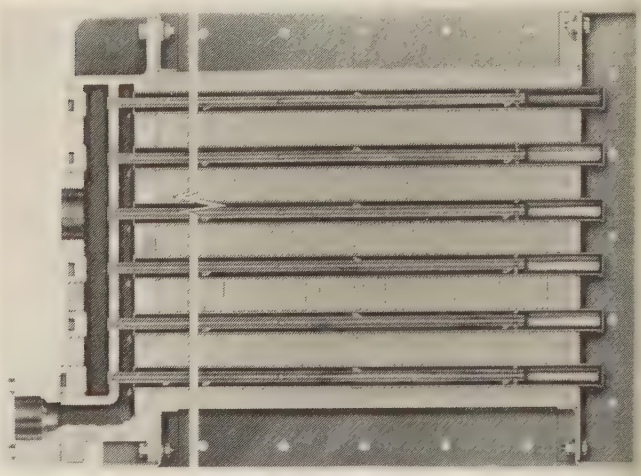

Fig. 11. Type SDS coil with steam distributing tubes

thermostatic traps rapidly eliminate condensate and air and the properly designed piping systems will give excellent results. Air elimination through a bucket trap is slow and it is usually desirable to provide auxiliary vents to take care of initial venting.

It is important that the traps be installed strictly in accordance with the manufacturer's instructions. Trap elevation is important and must be watched carefully. Be sure that the trap is well below the coil outlet so that condensate is not held in one or two tubes of the coil even when everything is functioning properly.

The method of control will govern the type of trap and piping arrangement. For instance, never use bucket traps on a system having overhead return lines with a modulating control system. Full steam pressure is needed to push the condensate through the trap and up into the return line. If control is to be realized by modulating the steam into the coil, the return line must drain by gravity through a float and thermostatic trap for best results.

Vacuum Breaker

On some installations it is desirable to use a vacuum breaker so that condensate will not be held in the coil.

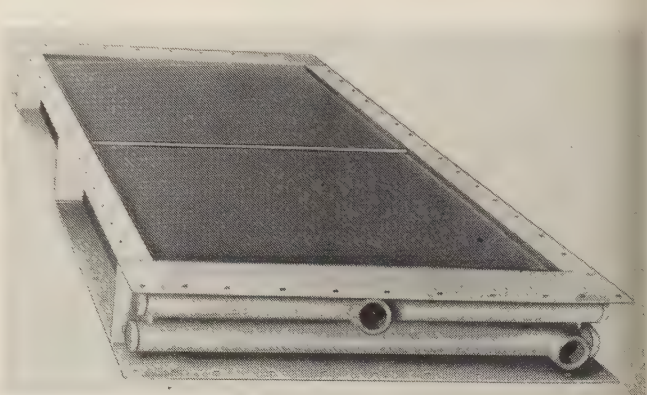

Fig. 12. Type WH heavy duty coil

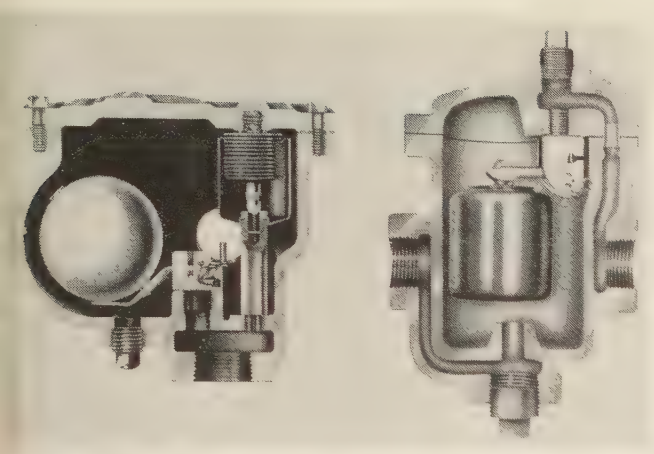

Fig. 13. Float and thermostatic trap

Figure 14 shows how the vacuum breaker can be utilized to equalize pressure between the coil and the return line. This apparatus is usually necessary on high-pressure steam installations where the steam may be throttled to a very low pressure or cut off entirely at times.

INSTALLATION

Shown in Fig. 15 are some of the things that must be watched in the supply and return piping on the bank of coils for a trouble-free installation. Be sure that supply lines are drained or condensate in such a way that the condensate from these lines does not flow into the coil. See that swing joints with a proper design are used so that the coil is not stressed due to piping expansion. On the return side of the coil there are several precautions that should be taken. The return lines should run full size of the return trapping in the coil down into a dirt pocket to be sure that the lower tubes in the coil are properly drained. It is just as important to provide swing joints on the return end as it is on the supply end. For proper trap operation, strainers should be provided.

Even though all of the rules of good practice are followed in making a coil installation, coils are always subjected to some stresses. Also, there are installations where the condensate is quite corrosive, and rapid corrosion is experienced. Recognizing these facts, a number of things have been done to strengthen the points where greatest stresses occur. For instance, on single tube and steam distributing tube coils having headers at opposite ends, a long bushing is used at the supply and return header. This bushing serves three purposes. On the supply end, it orifices the steam to each of the tubes, it provides a permanent steam typed tube header joint, and it reinforces the tube for a distance of about an inch outside of the header. This eliminates any possibility of tube breakage and tube corrosion near the header joints.

On some installations where conditions are unusually severe, extra heavy tubing, which prolongs coil life, has been used.

There have been cases where coils of the ordinary materials of coil construction such as copper, red brass, and carbon steel gave very little service. This has been overcome by furnishing coils having tubes of stainless steel. Where coils of copper or steel have failed in the matter of 6 months to a year, the use of stainless steel tube has eliminated the problem. Coils with stainless steel tubes cost about $2^1/_2$ times as much as standard coils with copper tubes, but under adverse conditions where early failure is experienced with standard coils, the use of stainless steel tubes can prove to be very economical.

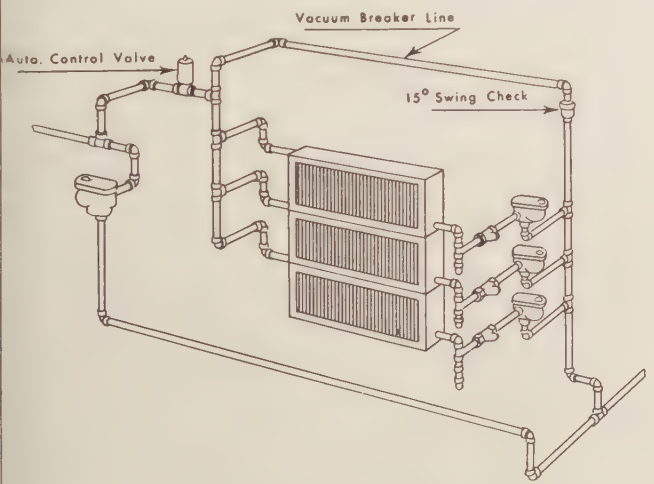

Fig. 14. Use vacuum breaker where necessary to thoroughly eliminate condensate

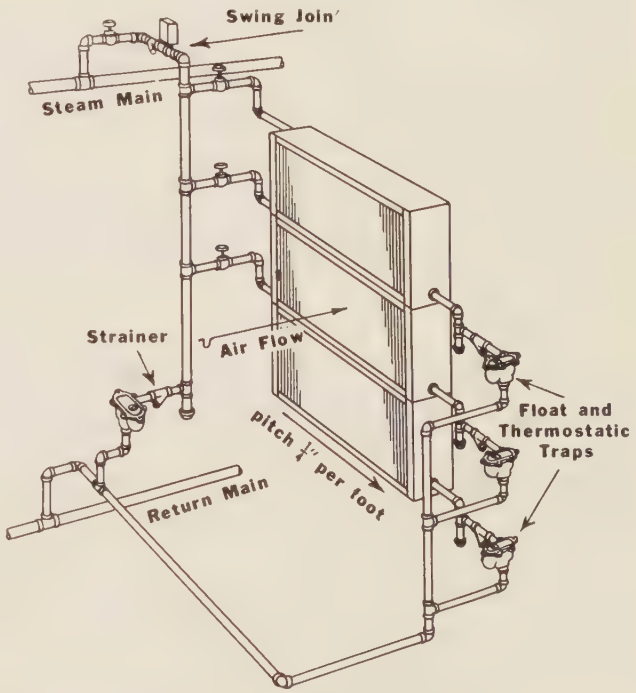

Fig. 15. A good coil installation

However, if trouble is due entirely to poor installation, special coil construction is a costly way to combat this difficulty. It does not cost a great deal more to install them properly. The correctly installed system is the most economical job, therefore it pays to do the job right the first time.

With quality equipment, properly installed and with proper control of the boiler feedwater, long economical life with low maintenance can be expected.

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A New Method for Studying the Solubility Properties of Cellulose Acetates

KARL BORGIN

The solubility properties of a cellulose manifest themselves in the variation of viscosity, viscosity anomalies, gel-structures, microgels, and molecular aggregates. It could be shown that there was a close connection between many of these properties and the ability of cellulose acetate to spread to monomolecular layers on a water surface. The spreading of cellulose acetate to monomolecular layers under suitable experimental conditions, also gives an indication of the type of cross links and chemical bonds that are responsible for the formation of microgels and molecular aggregates in solution. The effect of hydrogen bonds and other cross links on these structures was studied. It could be shown that cellulose acetates made from different commercial celluloses, contained two types of cross links, formed by bivalent ions or hydrogen bonds. Cellulose pulps refined by the cold alkali or the combined cold/hot alkali processes, contained a great number of resistant cross links which caused poor solubility properties of the corresponding acetates. It is believed that highly reactive celluloses from which cellulose acetates with good solubility properties can be made, only can be manufactured by hot alkali treatment in connection with multi-stage bleaching.

When macromolecular compounds dissolve they undergo swelling as a primary phenomenon. The solid absorbs the liquid, and its particles gelatinize as they increase in bulk, finally becoming completely miscible with the solvent. The solid and the solvent may become mutually miscible in all proportions, or a limited swelling may take place.

In some cases no solvent can be found that completely dissolves the macromolecular compound. A fully substituted cellulose acetate produced under certain conditions is insoluble in almost all solvents.

The solubility and insolubility of many high polymers in certain solvents are not easy to explain. Coltof (*2*) has put forward the view that different atom groupings of the solvents may exhibit swelling or dispersing action, and both these effects must take place simultaneously in order to dissolve the polymers.

Some polymers contain different forms of cross links which prevent the complete dissolution but not the swelling which may be rather extensive. If there are rather few cross links, the solid usually is broken up into small highly swollen fragments. These fragments may be of microscopic size, but if they are highly swollen they are not visible in a microscope since they have almost the same refractive index as the rest of the solution. These highly swollen particles, which we will term *microgels*, cannot be observed by ordinary microscopic technique, nor be observed by the scattering of visible light.

A solution containing microgels may look completely transparent to the eye, and the possible turbidity most certainly is caused by particles with a higher density and refractive index than the solution (fiber fragments, unswollen particles etc.).

The presence of microgels can, however, be observed by their clogging of suitable filters, their influence on the structural viscosity of the solution, or their effect on the spinning of monofilaments.

Even if the dissolution is apparently complete and if no ordinary effect of their presence can be observed, a rather great amount can be present in the form of molecular aggregates of various sizes.

We think that microgels of all sizes, from molecular aggregates to microscopic particles, will greatly influence what usually is called the solubility properties of a cellulose derivative.

When different cellulose derivatives are dissolved in the same solvent, they form solutions of different viscosities, filtering and spinning properties, various degrees of thixotropy, and with variations of structural viscosities of more or less defined nature. All these properties are according to our definition identical with the term solubility properties.

Seen away from the obvious influence of the average length of the molecules and their molecular weights, the variations found in different celluloses are to a great extent caused by the amount and the average size of the microgels.

Investigations on solubility properties are mostly done by observing their effect on viscosity, thixotropy, filterability, etc., but it can also be performed by studying microgels and molecular aggregates in solutions. That is the aim of the present investigation.

THEORETICAL

Several methods can be used to determine the amount of microgels if they are of filterable size. If the microgels are nonfilterable in the sense that they pass through ordinary sintered glass filters, only their presence can be observed, but their amount cannot be determined by ordinary methods. It is not possible to use filters with extremely small pores, such as membrane filters since they are clogged almost instantly.

During our study of monomolecular layers of cellulose derivatives (*9*) it became evident that there was a close connection between the spreading power of the derivative and its amount of microgels. We found that the method was extremely sensitive and the smallest amount of undissolved particles or microgels could be observed and measured.

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The spreading of monomolecular layers on a water surface has been developed to be a simple and accurate laboratory method. The most typical investigations on the spreading of monomolecular layers have been done on typical polar molecules with distinct hydrophobic and hydrophilic groups such as long chain alcohols and acids.

Fig. 1. Typical force/area curve of cellulose acetate. C spread on water, B spread on 1.5% guanidine solution, and A on 6% guanidine solution

It has also been shown that some high polymers can be spread on water to form more or less perfect monomolecular layers (*1, 3, 4, 6, 10, 11*).

Cellulose ethers were found to spread well and formed perfect monomolecular layers while some of the cellulose esters spread incompletely on pure water.

When cellulose derivatives form monomolecular layers on water, the glucose units lie flat on the water surface (*1, 10*). Because of the flexibility of the cellulose chain and the possibilities for rotation of glucose units about the oxygen bridges (*7*), the cellulose molecules in solution may assume many different configurations.

The hydroxyl groups are not equally distributed in all directions but are arranged in such a way that the cellulose chain has hydrophobic and hydrophilic surfaces (*7*). Both the flexibility of the cellulose chain and the arrangement of hydroxyl groups explain how cellulose derivatives can be attracted to the water surface by a great number of hydrophilic groups.

When a cellulose derivative such as cellulose acetate spreads on water, it does not spread completely, and the reasons for this most probably are: (1) the cohesion between cellulose acetate molecules is too strong compared with the attraction between the hydrophilic groups and the water phase; (2) cellulose acetate does not dissolve to a complete molecular solution, but a small part will consist of micelles, crystallites, microgels, or undissolved particles.

We were able to show (*9*) that both the strong cohesion between cellulose acetate molecules and the formation of microgels and molecular aggregates were responsible for the incomplete spreading of cellulose acetates. The close connection between solubility properties, the amount of microgels, and the corresponding spreading power was also studied.

Based on this we think that it is possible to study solubility properties by measuring the spreading power of cellulose acetates under suitable experimental conditions.

EXPERIMENTAL

The surface balance used to determine spreading power was of the Langmuir-Adam type, modified by Alexander. The instrument was direct reading and the sensitivity was 0.1 dyne per cm.

Cellulose acetates were dissolved in chloroform, and the concentration of the spreading solutions was 50 mg. cellulose derivative in 100 ml. of the solvent. The cellulose acetates were spread by a microburet (Agla syringe), and the amount put on the surface was 0.031 ml.

The spreading power of the cellulose derivatives was expressed as the area occupied by one substituted glucose unit or as the pressure set up at a compression of the monomolecular film that corresponds to 40 sq. A

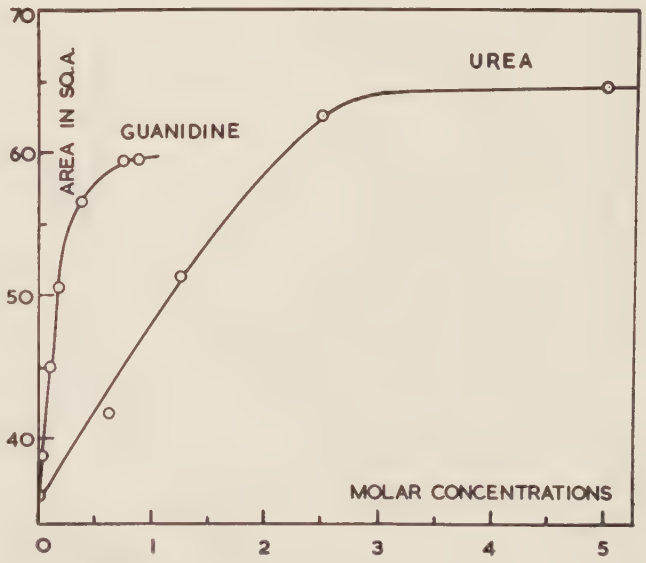

Fig. 2. Effect of guanidine and urea on the spreading power of cellulose acetate

per glucose unit. The spreading power was independent of the viscosity and molecular weight of the samples, which also was found by Katz, Samwel, and Adam (*1, 10*).

RESULTS

Cellulose acetates spread without difficulty from chloroform solutions and gave areas that correspond to 30 to 47 sq. A per esterified glucose unit.

A typical force/area curve is shown on Fig. 1, curve C. The area occupied by one glucose unit is obtained by extrapolating to zero pressure.

Effect of Hydrogen Bonds

The strong molecular cohesion in cellulose acetate will counteract the spreading to complete monomolecular layers. This cohesion is partly caused by the great number of hydrogen bonds between the cellulose chains. If hydrogen bonds could be split up or weakened, the spreading power would increase.

Table I

Sample	*Area per glucose unit in sq. A spread on water*	*Area per glucose unit in sq. A spread on 3% guanidine*
A	37.6	61.0
B	40.2	63.1
C	40.9	62.7
D	41.3	63.4

This was accomplished by spreading cellulose acetates on aqueous solutions of guanidine and urea, and the spreading power increased considerably.

Table I shows the area occupied by one glucose unit when various cellulose acetates were spread on water and a 3% guanidine solution.

The highest value obtained was on 30% urea solutions and corresponded to 73 sq. A per glucose unit.

Figure 2 shows a cellulose acetate (cotton linters, 58% acetate content) spread on various concentrations of guanidine and urea. Maximum spreading is reached with 0.75 molar concentration of guanidine, but a 2.2 molar concentration of urea is needed to give the same results. The force/area curve when cellulose acetate is spread on guanidine is shown in Fig. 1.

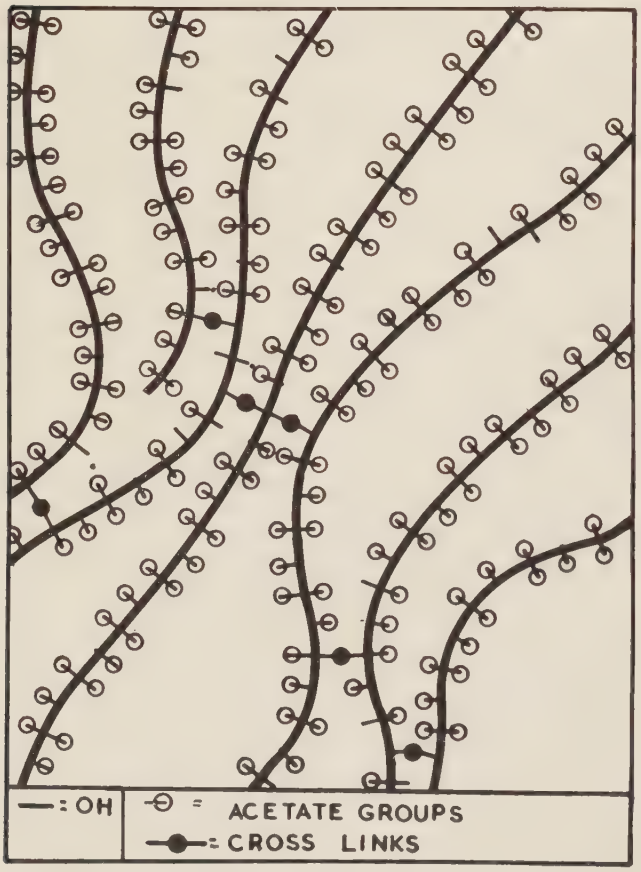

Fig. 3. Structure of microgel with cross links formed by bivalent ions

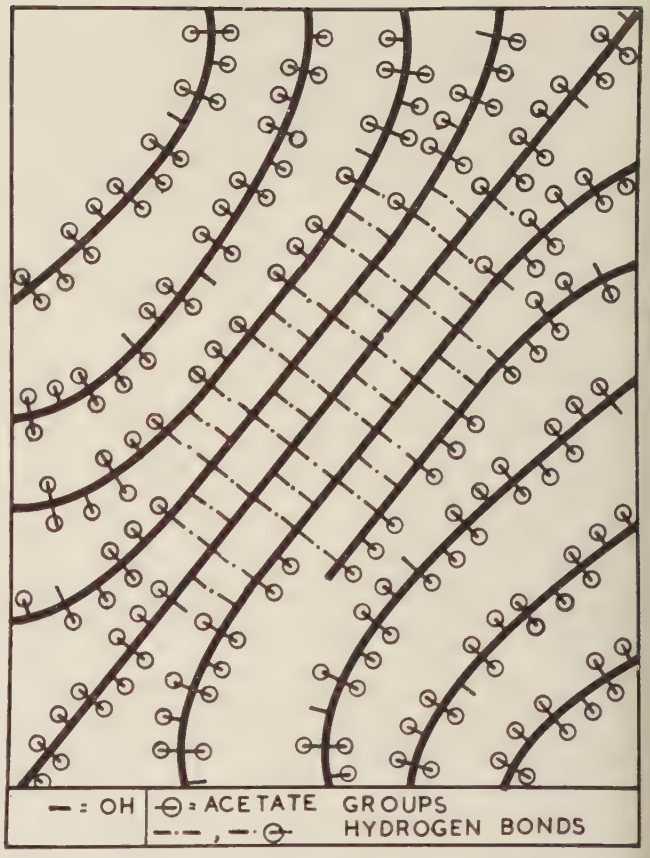

Fig. 4. Structure of microgel with numerous hydrogen bonds caused by incomplete reaction of the micelles

Undissolved Particles and Microgels

The effect of undissolved particles on the spreading power was studied by spreading filtered and unfiltered cellulose acetates and by spreading samples run in an ultracentrifuge with extremely high speed (20,000 r.p.m.).

The increase in spreading power after filtration or centrifugation could be as high as 20%, while the same increase by using hydrogen bond breaking compounds (guanidine and urea) in many cases was higher than 90%.

An extremely interesting effect was observed when the cellulose acetate contained cross links other than hydrogen bonds.

The cross links were introduced in several ways by treating cellulose acetates with bivalent ions, salt solutions, formaldehyde and other reagents. The spreading power decreased considerably when the solutions were spread on water, and also when the same solutions were spread on guanidine and urea.

The spreading power under suitable experimental conditions is therefore an indication of the nature and the number of different cross links between the molecules of cellulose acetates.

Based on this we developed the following procedure to study the amount of undissolved material, micro-

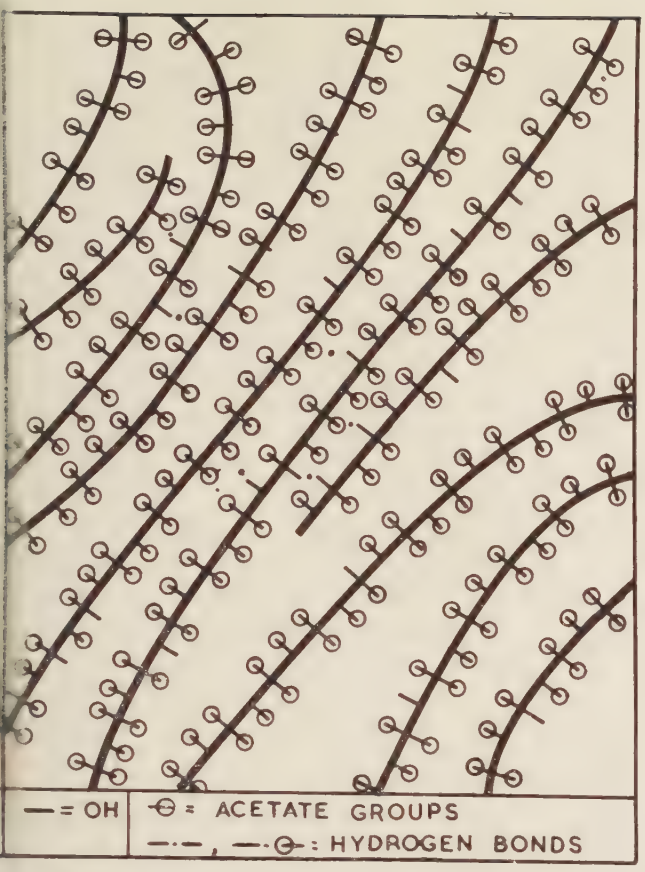

Fig. 5. Structure of molecular aggregates formed at higher concentrations

gels, and other molecular aggregates in the cellulose acetate solutions.

1. The cellulose acetate is first dissolved and the spreading power measured. The same sample is then filtered through a sintered glass filter, and the spreading power of the filtered sample is determined. (Corrections must be done for the decrease in concentration.) The difference in spreading power between filtered and unfiltered samples is a measure of the amount of undissolved particles and microgels of filterable size.

2. The filtered and unfiltered solutions are spread on a 3% guanidine solution, and the area is measured.

If the cellulose acetate only contained hydrogen bonds, all cellulose acetates would reach the same value of spreading power by breaking the hydrogen bonds. Since this is not always so, the cellulose acetate molecules in some samples must be held together with other types of bonds or cross links.

The difference between the highest value of spreading power that can be measured on guanidine, and the one actually measured, is an expression of the amount of cross links different from hydrogen bonds. (Filtered acetates of the best cotton linters can be used for comparison.)

If a cellulose acetate gives a small area when spread on water, but spreads completely on guanidine, microgels or molecular aggregates are held together by hydrogen bonds and not by other cross links. A typical example is microgels caused by the incomplete acetylation of the interior of the micelles (Fig. 4 and Table II).

Table II

Structure	Undissolved particles and microgels (Fig. 3)	Microgels (Fig. 4)	Microgels and molecular aggregates (Fig. 5)
Size of structure	Macroscopic-microscopic-submicroscopic	Microscopic-submicroscopic	Mainly submicroscopic
Type of bonds	Crosslinks formed by bivalent ions etc.	Numerous hydrogen bonds caused by incomplete reaction of micelles	Hydrogen bonds
Spreading power on water	Low	Low	High
Spreading power on guanidine and urea solutions	Low	High	High
Effect of filtering on spreading power	Great to small	Negligible	None

The chains in the interior contain a greater amount of hydrogen bonds than the fully acetylated molecules, and they do not spread completely on water. When the hydrogen bonds are more or less split up by urea and guandine, a complete spreading takes place.

Even when a cellulose acetate is completely acetylated and apparently dissolved without any signs of undissolved particles or microgels, some kind of molecular aggregates are found. The spreading power of most cellulose acetates increase with dilution (Fig. 6), and the only explanation is that a small portion of the

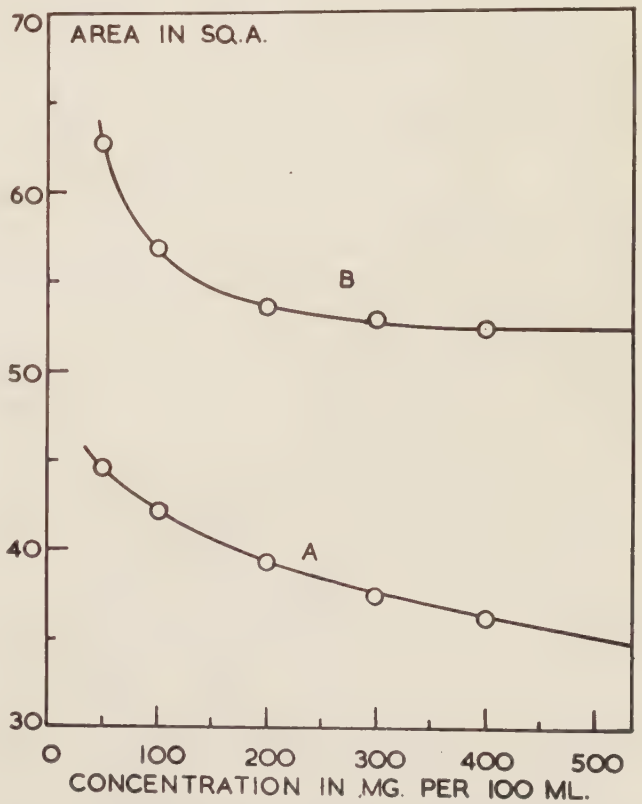

Fig. 6. Increase of spreading power with dilution. Cellulose acetate spread on water (A) and cellulose acetate spread on 3% guanidine (B)

cellulose acetate is not dissolved completely to individual molecules, but form molecular aggregates. deVore and Davey (*5*) found the same when cellulose nitrate was diluted. We think that the molecular aggregates cannot be identified with crystalline micelles, but the molecules in the aggregates are certainly held together with hydrogen bonds that partly are broken by dilutions (curve A, Fig. 6), and almost completely split up by hydrogen bond breaking compounds (curve B, Fig. 6).

Solubility Properties of Cellulose Acetates Made from Different Commercial Celluloses

Cellulose acetates made from celluloses produced by different manufacturing processes exhibit great variations in their solubility properties. This is obvious from the differences observed with respect to filterability, structural viscosity, turbidity, and amount of microgels.

Since we have found a close connection between solubility properties and spreading power, we measured the spreading power of several different cellulose acetates.

The different cellulose samples were acetylated under identical conditions, dissolved in chloroform and spread on water from 3% guanidine (Figs. 7 and 8). The acetates were made from the following celluloses:

1. Sulphite pulp from spruce, bleached and cold alkali refined.
   Alpha-cellulose 96.9%
   Pentosan 0.8%
   Viscosity (TAPPI 206 m) ..... 28.9 cp.
2. Sulphite pulp from spruce, bleached and refined by combined cold/hot alkali treatment.
   Alpha-cellulose 96.2%
   Pentosan 0.7%
   Viscosity (TAPPI 206 m) ..... 23.4 cp.
3. Sulphite pulp (for viscose rayon) from spruce, bleached and hot alkali refined.
   Alpha-cellulose 91.2%
   Pentosan 2.2%
   Viscosity (TAPPI 206 m) ..... 20.5 cp.
4. Sulphite pulp (for acetate rayon) from spruce, bleached and hot alkali refined.
   Alpha-cellulose 95.1%
   Pentosan 2.0%
   Viscosity (TAPPI 206 m) ..... 26.5 cp.

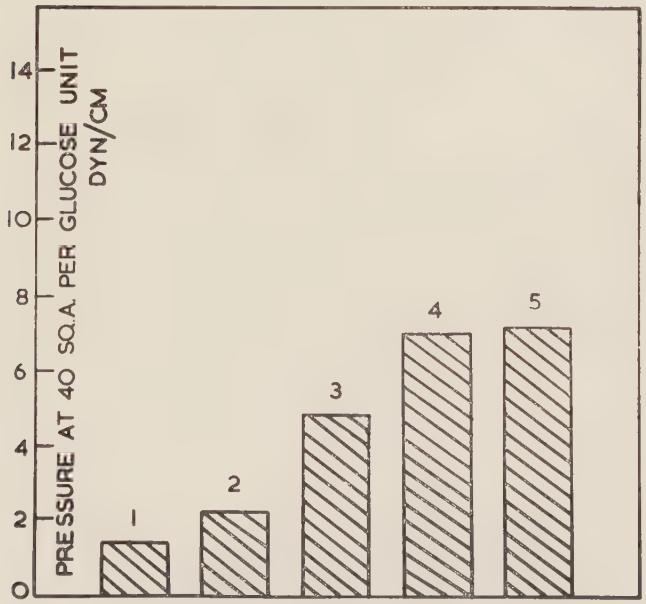

Fig. 7. Spreading power of cellulose acetates made from various commercial celluloses. Spread on water. For further explanation see text

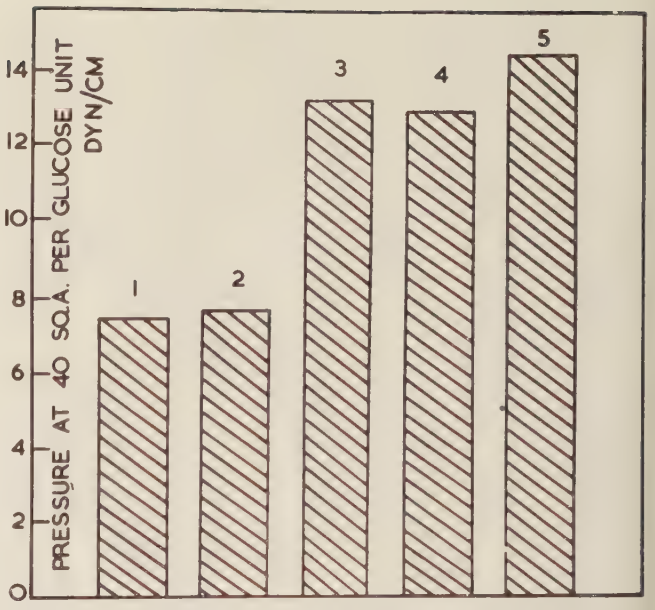

Fig. 8. Spreading power of cellulose acetates made from various commercial celluloses. Spread on guanidine. For further explanation see text

5. Cotton linters, acetate grade.
   Alpha-cellulose 98.4%
   Pentosan 0.4%
   Viscosity (TAPPI 206 m) ..... 41.2 cp.

From the spreading power of the acetates made from these celluloses and from similar experiments, we have drawn the conclusion that cellulose acetates produced from celluloses that have been refined by cold alkali or cold/hot alkali treatment contain a large portion of microgels which mainly are caused by cross links different from hydrogen bonds.

We think it is rather significant that this type of cross links is found when cellulose acetate is made from celluloses which in one way or another have been treated with strong concentrations of alkali.

One reason for the difficulties involved in the manufacture of a *reactive* cold alkali treated cellulose (*8*) is that such celluloses easily form cross links.

It might be that a *complete* reactivation of celluloses treated with cold alkali or combined cold/hot alkali is almost impossible because of their resistant cross links. As already Jayme and Schenck (*8*) have pointed out, it is probable that a very reactive cellulose cannot be produced if the cellulose has been treated with cold alkali.

Modern hot alkali treatment with multistage bleaching, is to be preferred since it not only produces a cellulose of high reactivity, but also gives cellulose acetates with excellent solubility properties.

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ASSOCIATION NEWS AND EVENTS

ighth Engineering Conference Program

The Eighth Engineering Conference of the Technical sociation of the Pulp and Paper Industry will be held at Sheraton-Mt. Royal Hotel, Montreal, P. Q., on Oct. -29, 1953. Following is the tentative program.

Monday, October 26

30 a.m. REGISTRATION (Foyer)

15 a.m. GENERAL SESSION (Champlain Room)

. SIBLER, West Virginia Pulp & Paper Co., New York, N. Y. *Chairman*

Address of Welcome

30 a.m. HYDRAULICS SESSION (Champlain Room)

J. MACKENZIE, Eastman Kodak Co., Rochester, N. Y., *Chairman*

"Forming Board Hydraulics," by J. B. Gough, Mead Corp., Chillicothe, Ohio

"Progress Report on Pipe Friction Studies," by R. E. Durst, University of Maine, Orono, Me.

1:00 a.m. ENGINEERING RESEARCH AND MACHINE DESIGN SESSION (Champlain Room)

D. LYALL, Armstrong Cork Co., Lancaster, Pa., *Chairman*

"Constant Tension Devices," by George C. Ehemann, Jr., The Ohio Boxboard Co., Rittman, Ohio, and R. C. Berger, General Electric Co., Cleveland, Ohio

"The Application Aspects of Paper Machine Differential Drives," by Sterling Skinner, Beloit Iron Works, Beloit, Wis.

"The Mechanics of Stress and Strain Occurring in a Fourdrinier Wire," by John D. Lyall, Armstrong Cork Co., Lancaster, Pa.

:30 p.m. ENGINEERING DIVISION LUNCHEONS

Drying and Ventilating Committee
Materials Handling Committee
Mill Maintenance and Materials Committee
Chemical Engineering Committee

:00 p.m. ELECTRICAL ENGINEERING SESSION (Champlain Room)

W. FOSTER, Champion Paper and Fibre Co., Canton, N. C., *Chairman*

"Grounded versus Ungrounded Power Systems—a Demonstration. Review of Operating Experience," by George P. Hobbs, Bowater's Newfoundland Pulp & Paper Mills, Ltd., Corner Brook, Newfoundland, Canada, and R. H. Kaufmann, General Electric Co., Schenectady, N. Y.

"An Engineering Analysis of Down Time of Electric Sectional Drives," by R. F. Sorenson, Union Bag and Paper Corp., Savannah, Ga.

3:45 p.m. DISCUSSION MEETINGS

Hydraulics
Discussion of University of Maine project on "Pipe Friction Studies" and the J. B. Gough Paper on "Forming Board Hydraulics"

Engineering Research and Machine Design
Discussion of main session topics

Electrical Engineering
"Selection of Chipper Drives" (preliminary report), by M. J. Osborne, Bowater's Southern Paper Corp., Calhoun, Tenn.

"Discussion of Cable Report," by A. O. Mortenson, St. Regis Paper Co. Pensacola Fla.

DINNER—(WHERE YOU WILL)

Tuesday, October 27

9:00 a.m. DRYING AND VENTILATING SESSION (Champlain Room)

CURT A. YOUNG, Riegel Paper Corp., Milford, N. J., *Chairman*

"Rate of Drying Through Paper Machine Driers," by A. E. Montgomery, J. O. Ross Engineering Co., Chicago, Ill.

Second paper (to be announced)

10:30 a.m. MATERIALS HANDLING SESSION (Champlain Room)

A. P. SCHNYDER, Ebasco Services, Inc., New York, N. Y., *Chairman*

"Use of Gasoline versus Electric Trucks in the Paper Industry," by R. F. Weber, International Harvester Co., Chicago, Ill.

"Economics of Various Methods of Handling Mill Supply Chemicals," by H. A. Stoess, Jr., Fuller Co., Catasauqua, Pa.

12:30 p.m. ENGINEERING DIVISION BUSINESS LUNCHEONS

Hydraulics Committee
Engineering Research and Machine Design Committee
Electrical Engineering Committee
Mill Design and Economic Aspects Committee
Steam and Power Committee

2:00 p.m. MILL MAINTENANCE (Champlain Room)

H. F. PARKER, New York and Pennsylvania Co., Lock Haven, Pa., *Chairman*

"The Maintenance of Bleach Plant Equipment," by Harold H. Huseby, Northwest Paper Co., Cloquet, Minn.

"The Application of Non-Corrosive Materials" (author to be announced)

3:30 p.m. Discussion Meetings

Drying and Ventilating (program later)
Materials Handling
Discussion of "Economics of Various Methods of Handling Mill Supply Chemicals"
Mill Maintenance
"Maintenance of Pipelines—Internal Cleaning," by Carl W. Ziegenbusch and M. V. Jones, Mead Corp., Chillicothe, Ohio

6:00 p.m. Social Hour (Champlain Room)

7:30 p.m. Dinner (Ball Room)

B. K. Sandwell, Toronto, Ont., Canada, speaker

Wednesday, October 28

9:00 a.m. Digester Corrosion Session (Chemical Engineering) (Champlain Room)

J. R. Lientz, Union Bag and Paper Co., Savannah, Ga., Chairman, Chemical Engineering, *Chairman*

Nicholas Shoumatoff, West Virginia Pulp & Paper Co., New York, N. Y., Chairman, Digester Corrosion Subcommittee, *Co-chairman*

"Comparative Analysis of Digester Corrosion Measurements," *Co-chairman* by T. E. Caywood, Armour Research Foundation, Chicago, Ill.
"The Cause or Causes of Corrosion in Alkaline Pulping Equipment," by Claud B. Christiansen, Pulp and Paper Research Institute of Canada, Montreal, P. Q.
"Cathodic Protection of Digesters," by E. W. Keith, Penobscot Chemical Fibre Co., Great Works, Me.
"Safety Evaluation and Protection of Digester," by W. B. Parker, Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn., and H. M. Canavan, Mutual Boiler and Machinery Insurance Co., Boston, Mass.

10:30 a.m. Mill Design and Economic Aspects Session (Champlain Room)

R. A. Packard, Mutual Security Agency, Washington, D. C., *Chairman*

"Pulp and Paper Plant Building Construction in Canada," by F. M. Kraus, Stadler, Hurter & Co., Montreal, P. Q.
"Fire Protection in Pulp and Paper Mills," by a representative of the Factory Insurance Association

12:30 p.m. Engineering Division Luncheon

Douglas W. Ambridge, President, Abitibi Power and Paper Co., Ltd., Toronto, Ont., Canada, speaker

2:30 p.m. Steam and Power Session (Champlain Room)

W. Wyburn, Federal Paper Board Co., Inc., Bogota, N. J., *Chairman*

"Functioning of the Boiler Code as It Pertains to the Paper Industry," by E. C. Korten, Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn.
"Case History—850 P.s.i.g. Topping Turbine at St. Regis Paper Co., Deferiet, N. Y.," by representatives of Chas. T. Main, Inc., and St. Regis Paper Co.

3:45 p.m. Discussion Meetings

Digester Corrosion
Discussion of session papers
Mill Design and Economic Aspects
Discussion of session paper "Pulp and Paper Plant Building Construction in Canada"
Steam and Power
"Interpreting Performance Curves of Single- and Double-Extraction Turbines and the Use of Heat Rates as a Method of Calculating Power Costs," by J. Gottlieb, Westinghouse Electric Corp., New York, N. Y.

7:00 p.m. Dinner Meeting for Committee Chairmen and Secretaries

Review of Eighth Engineering Conference
Discussion of 1954 meeting
Review of Engineering Division Projects
TAPPI Data Sheets

Thursday, October 29

9:00 a.m. The official plant tour will be to the Dominion Engineering Co. Other visits, on an individual basis, are also available

Statistics Conference

The Conference on Application of Statistical Methods in the Pulp and Paper Industry, cosponsored by the TAPPI Statistics Committee and Western Michigan College is now in progress (June 15–26, 1953) at Kalamazoo, Mich. More than 35 individuals are taking the course. John Langmaid, Jr., of S. D. Warren Co., Cumberland Mills, Me., is chairman of the TAPPI Statistics Committee.

Fall Conferences

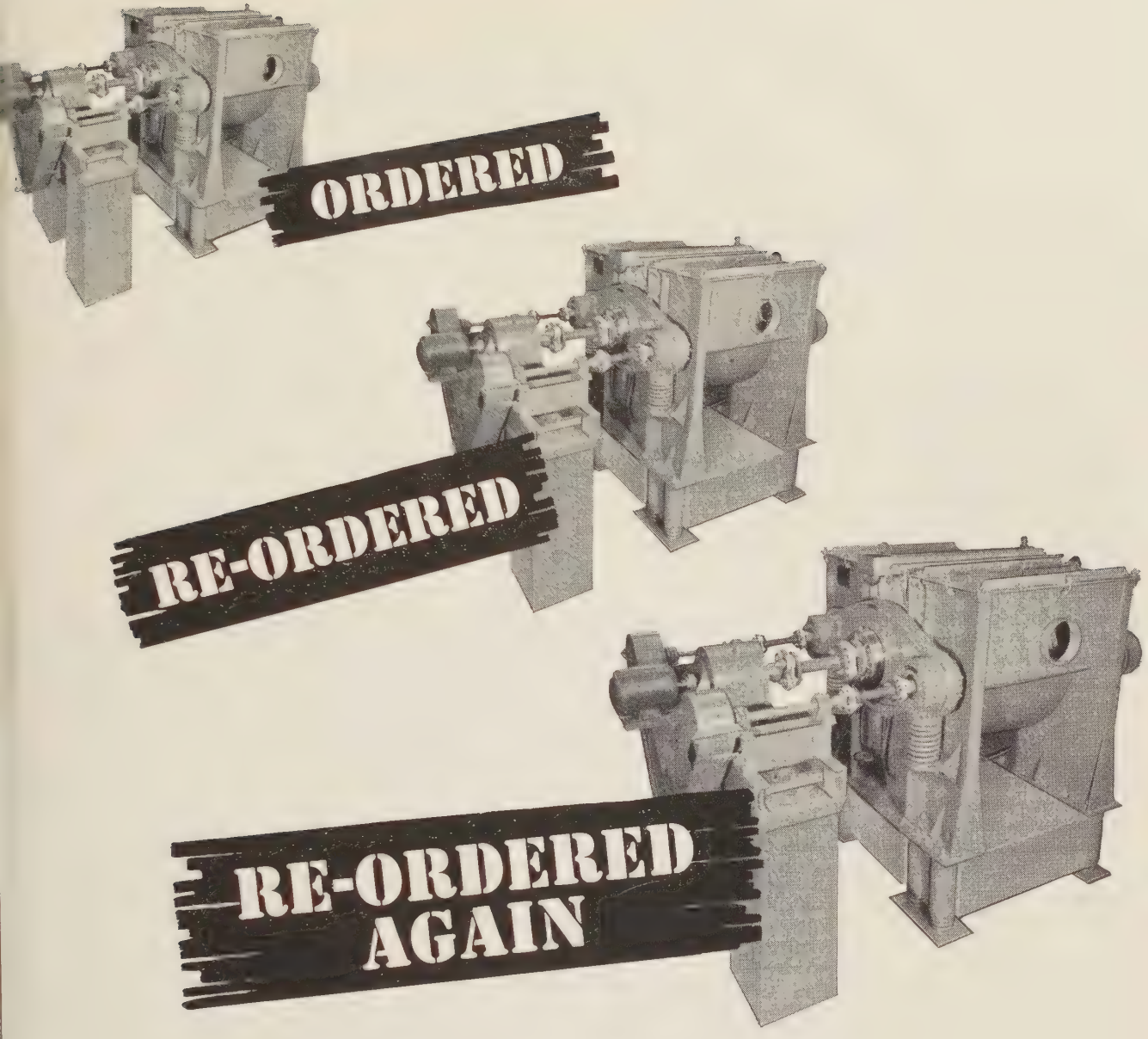
Five TAPPI functional conferences have been scheduled for the Fall of 1953.

Plastics Conference—College of Forestry, State University of New York, Syracuse, N. Y., Sept. 15–16, 1953. R. T. Nazzaro, Westfield River Paper Co., *Chairman.*

Fibrous Agricultural Residues Conference—Trenton, Ont., Canada, Oct. 8–9, 1953. S. I. Aronovsky, Northern Regional Research Lab., Peoria, Ill., *Chairman;* William H. Palm, Hinde & Dauch Paper Co. of Canada, Ltd., *Local Chairman.*

Corrugated Containers Conference—Statler Hotel, New York, N. Y., Oct. 14–15, 1953. The program will feature, "Printing of Corrugated Containers." Burt Mendlin, Cornell Paperboard Products, Inc., Milwaukee, Wis., *General Chairman.* The Conference Committee consists of Keith Max, Robert Gair Co., Uncasville, Conn., *Chairman;* W. W. Fitzhugh, Jr., William W. Fitzhugh, Inc., Brooklyn, N. Y.; J. P. Greiveldinger, Robert Gair Co., New York, N. Y.; T. J. Gross, Union Bag & Paper Corp., New York, N. Y., and E. A. Taub, Gibralter Corrugated Paper Co., North Bergen, N. J.

Engineering Conference—Sheraton-Mount Royal Hotel



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Montreal, P. Q., Canada, Oct. 26–29, 1953. CHARLES J. SIBLER, West Virginia Pulp & Paper Co., New York, N. Y., *General Chairman;* WALTER C. BLOOMQUIST, General Electric Co., Schenectady, N. Y., General Secretary.

Alkaline Pulping Conference—Rice Hotel, Houston, Tex., Nov. 18–20, 1953. FRED BISHOP, Southland Paper Mills, Lufkin, Tex., *Chairman.* Program includes tour of the mill of the Champion Paper & Fibre Co., Pasadena, Tex.

Jack Winchester Appointed

A. John (Jack) Winchester has joined the staff of the Technical Association of the Pulp and Paper Industry in New York City, and will devote his efforts to the activities of the Association's divisions and committees.

A. John Winchester

Born in Winnipeg, Man., Canada, Mr. Winchester is a graduate of the University of Manitoba in 1942 and held several positions in the Canadian pulp and paper industry before coming to the United States. From 1942 to 1944 he was Chemist for the Aluminum Company of Canada at Arvida, Que. From 1945 to 1947 he was employed by Price Brothers & Co., Ltd., first as Assistant Chemist at Kenogami and later as Chief Chemist at Jonquiere. In 1949 he became Chief Chemist of the Donnacona Paper Co., Donnacona, Que., and in 1950 he was appointed Groundwood Superintendent of Donnacona.

He was an active member of the Technical Section of the Canadian Pulp and Paper Association, serving on the Testing, Board, Standards, and Mechanical Pulping Committees. He was also a member of the Executive Committee of the Quebec District Branch of the Section.

Foreign Association Chairmen

Henning Wadell, Wifstavarfs A/B, Vivstavarv, Sweden, has been elected chairman of the Swedish Paper & Pulp Engineers Association. Lars Ekelund of Holmens Bruks och Fabriks A/B, Hallstavik, Sweden, was elected vice-chairman. On Jan. 1, 1953, the Association had 685 members.

I. G. Burns of J. A. Weir, Ltd., Forth Mills, Kilbazie by Alloa, Clackmannan, Scotland, has been elected chairman of the Technical Section of the British Paper and Board Makers' Association, St. Winifred's, Welcomes Rd., Kenley, Surrey, England.

TAPPI Office

Late in June the central office of the Technical Association of the Pulp and Paper Industry will move from 122 E. 42nd St. to 155 E. 44th St., New York 17, N. Y. The removal date is not exact since the present tenant on 44th St. has been awaiting the completion of a new building, following which some time will be required to prepare the new offices for occupancy. During the change-over period mail can be addressed to the present address 122 E. 42nd St., New York 17, N. Y.

Papermaking (Cylinder) Committee

Glenn T. Renegar, Superintendent of the Paper Mill Div., Container Corp. of America, Manayunk, Pa., has succeeded James J. Harrison, Michigan Carton Co., Battle Creek, Mich., as chairman of the TAPPI Papermaking (Cylinder) Committee.

Pulps for Chemical Conversion Committee

The establishment of a Pulps for Chemical Conversion Committee is announced by R. G. Macdonald, Secretary of the Technical Association of the Pulp and Paper Industry. The scope of TAPPI's newest committee is: the preparation and requirements of pulps for chemical conversion; the study of the conversion processes. It has been placed in the Pulp Manufacture Div. of which George A. Day is general chairman.

The new committee is an outgrowth of the Plastics Committee's Subcommittee on Cellulosic Materials. Personnel at time of transition are:

R. S. Apple, Explosives Dept., E. I. du Pont de Nemours and Co., Inc.
Roe C. Vlume, Acetate Research, E. I. du Pont de Nemours and Co., Inc.
Sydney Coppick, American Viscose Corp.
Merle A. Heath, The Buckeye Cotton Oil Co.
C. V. Holmberg, College of Forestry, New York State University
Edward J. Howard, Industrial Cellulose Research, Ltd.
Albert T. Maasberg, Dow Chemical Co.
Douglas H. McMurtrie, Brown Co.
W. E. Roseveare, Viscose Research, E. I. du Pont de Nemours and Co., Inc.
Milton O. Schur, Ecusta Paper Corp.
Peter Van Wyck, Hercules Powder Co.
Forrest A. Simmonds, *Chairman*, pursuant to subsequent action of the committee, U. S. Forest Products Lab.

Up to the time of undertaking the chairmanship of the Pulp Manufacture Div., George A. Day was a member of the former subcommittee.

At the 1950 Annual Meeting of TAPPI, E. C. Jahn, as chairman of the Plastics Committee, completed the organization of a Subcommittee on Cellulosic Materials. It was soon evident, however, that the interests of the group were mainly in a field beyond the scope of the subcommittee. Uses accounting for the major consumption of pulps for chemical conversion are not usually classed as plastics.

Consideration of the economic importance of these special pulps, the complexity of the many problems in their production and use, and the fact that this field is not served directly by a TAPPI committee led the subcommittee to petition for full committee status.

The new committee proposes to function primarily as a research advisory and coordinating group. It will thus avoid duplication of work within the scope of certain existing TAPPI committees. It plans to develop and maintain an integrated program of research. With this as a basis, it will then advance suggestions for specific projects to the appropriate TAPPI committee. It will not presume to conduct or sponsor projects in the fields of other TAPPI committees. In addition, and this may be its greatest potential value, the research program will be brought to the attention of academic groups

Glenn T. Renegar

Forrest A. Simmonds

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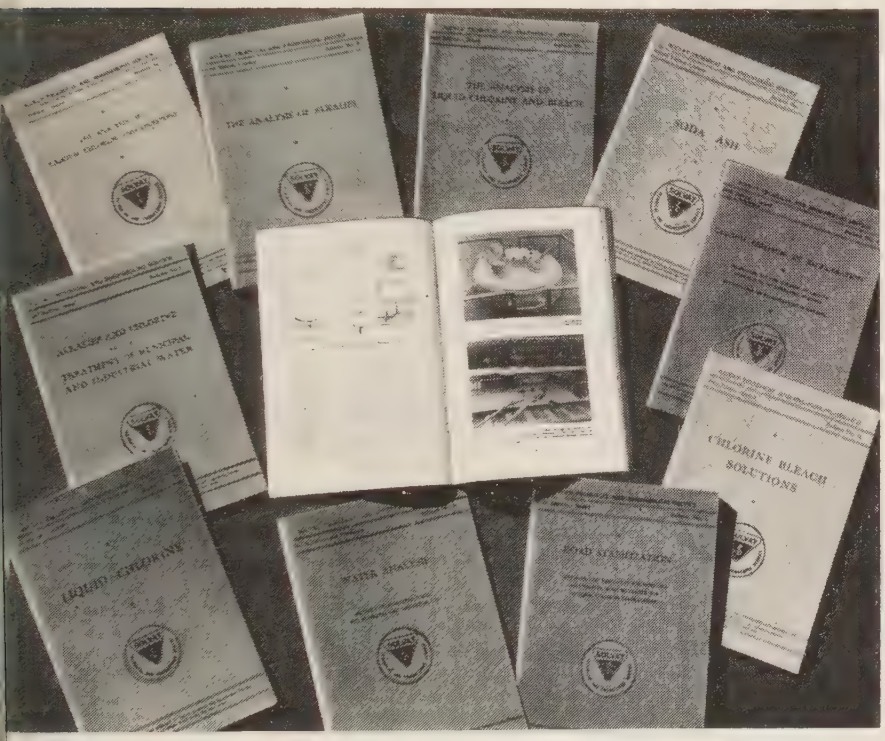

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The committee will consider relations of: (1) variations in wood quality within and between species as affecting pulp and product characteristics, (2) influence of the pulping and purification processes and their variables on pulp and product characteristics, and in addition (3) methods for evaluating the effects of these variables, and (4) special tests for predicting technological suitability.

A subcommittee organization will be considered by the committee.

At the 1954 Annual Meeting of TAPPI, the new committee will sponsor a formal morning session for the presentation of papers within its scope and an afternoon informal discussion with emphasis to be placed on requirements for uses.

Anyone wishing to take part in either or both phases of the forthcoming program or to join the committee should address Forrest A. Simmonds, *Chairman,* Pulps for Chemical Conversion Committee, Forest Products Lab., Madison 5, Wis.

The following is an outline of subject matter to be considered by proposed TAPPI Committee on Pulps for Chemical Conversion:

I. Raw materials
  A. Cotton linters
  B. Wood
    1. Softwoods
    2. Hardwoods
      (a) Physical characteristics and chemical composition in relation to those of unbleached pulps produced by various pulping processes
      (b) Polymolecularity of the cellulose isolated by the TAPPI procedure for holocellulose and by nitration
      (c) Polymolecularity of the so-called alpha cellulose
      (d) Hemicelluloses in the pulps and persisting in the so-called alpha cellulose
II. Pulping processes
  A. Neutral sulphite semichemical
  B. Nitric acid
  C. Soda
  D. Sulphate, including prehydrolysis-sulphate
  E. Sulphite
III. Properties and characteristics of unbleached pulps
  A. Physical
  B. Chemical
IV. Purification treatments
  A. Chlorination
  B. Alkaline extraction
    1. Hot process
    2. Cold process
  C. Oxidation
  D. Additives
  E. Acid extraction
  F. Water and other chemicals
V. Characteristics of purified pulps
  A. Physical
    1. Bulk form
    2. Sheet form
      (a) Preparation variables
      (b) Additives
      (c) Structure
    3. Disperse viscosity
    4. Polymolecularity
  B. Chemical
    1. Conventional
    2. Specialized
VI. Requirements placed upon pulps by the various chemical conversion processes
VII. Requirements placed upon end products
VIII. Variables of the conversion processes
IX. Correlations of characteristics of raw materials and of end products
X. Methods for evaluation of pulps and products of conversion

Certified Pulp Testers

The following list of individuals and companies have been approved by the Certified Pulp Testers Bureau of commercial weighing, sampling, and testing wood pulp for moisture.

Pulp and Paper Mill Laboratories

Bringman, Robert E., St. Joe Paper Co., Port St. Joe, Fla.
Brown, W. W., Howe Sound Pulp Co. Ltd., Port Mellon, B. C., Canada
Church, D. F., Crown Zellerbach Corp., Camas, Wash.
Clark, Clarence T., Restigouche Co., Ltd., Campbellton, N. B., Canada
Enghouse, Clarence A., Crown Zellerbach Corp., West Linn, Ore.
Gorham, A. B., Ontario Paper Co. Ltd., Thorold, Ont., Canada
Guest, Eric T., MacMillan & Bloedel Ltd., Harmac Pulp Div., P. O. Drawer 18, Nanaimo, B. C., Canada
Hartnagel, Nelson, Fibreboard Products, Inc., Port Angeles, Wash.
Ingram, C. D., Hollingsworth and Whitney Co., P. O. Box 1189, Mobile 7, Ala.
McLean, E. A. G., MacMillan & Bloedell (Alberni) Ltd., Port Alberni, B. C., Canada
Marriott, Robert R., Crown Zellerbach Corp., Port Townsend, Wash.
Moden, F. P., Anglo-Canadian Pulp and Paper Mills, Ltd., Quebec, P. Q., Canada
Smith, C. L., National Container Corp., P. O. Box 1620, Jacksonville, Fla.
Tennent, G. R., Hummel-Ross Div., Continental Can Co., Hopewell, Va.
Thieme, R. I., Soundview Div., Scott Paper Co., Everett, Wash.
Wayman, Dr. M., Columbia Cellulose Co. Ltd., Engineering Dept., P. O. Box 1000, Prince Rupert, B. C., Canada
Weleber, F. J., Publishers Paper Co., Oregon City, Ore.

Commercial Laboratories

Andrews, A. B., Box 57, Lewiston, Me.
Danneker & Evans, Inc., 309 Camp St., New Orelans, La.
Donald & Co., Ltd., J. T., 1181 Guy St., Montreal, Que., Canada
Goodrich, Neil C., South Haven Terminal Co., Inc., 251 Center St., South Haven, Mich.
Gulick-Henderson Laboratories, 431 S. Dearborn St., Chicago 5, Ill.
Hamlin & Morrison, 216 S. 2nd St., Philadelphia, Pa.
Landes, William, Paper and Pulp Testing Lab., 118 E. 28th St., New York, N. Y.
Orthmann Labs., Inc., 922 N. 4th St., Milwaukee, Wis.
Paquin and Associates, Felix (Galveston Laboratories), Galveston, Tex.
Skinner & Sherman, Inc., 246 Stuart St., Boston, Mass.
Sutliff, John H., Font Grove Rd., Slingerlands, N. Y.
U. S. Testing Co., Inc., 1415 Park Ave., Hoboken, N. J.
Whittington, E. F., 530 W. Cedar St., Kalamazoo 45, Mich.
Wiley & Co., Inc., 504 N. Calvert St., Baltimore, Md.
Williams Apparatus Co., Inc., Herald Bldg., Watertown, N. Y.

New Corporate Members (1953)

The following Companies have become corporate members of the Technical Association during the current year.

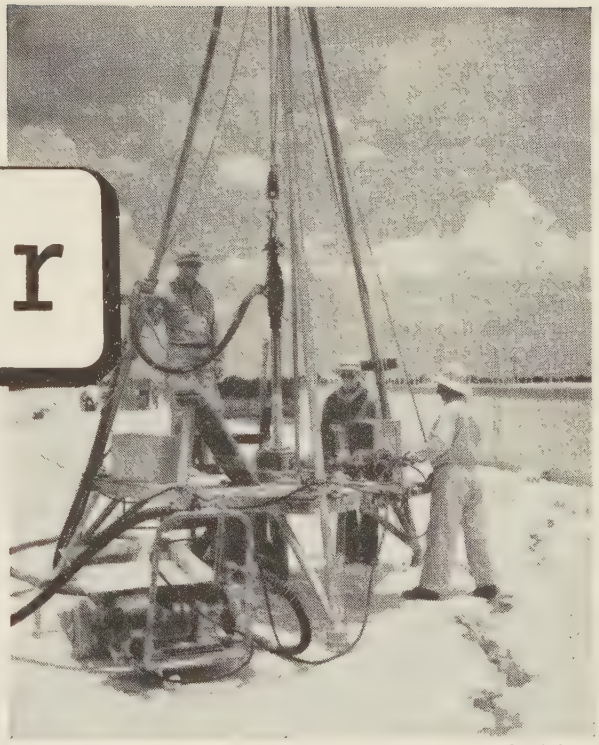
d'Alizay, Soc. Ind. de Cellulose, Alizay, France
Corning Fibre Box Co., Corning, N. Y.
Downing Box Co., Milwaukee, Wis.
Ganstoff-Courtaulds G.m.b.H., Koln-Weidenpesch, Germany
Hoague-Sprague Corp., Lynn, Mass.
Lenzinger Zellulose Papierfabrik A/G, Lenzig, Austria
Line Material Co., Sherman, Tex.
Menasha Wooden Ware Corp., Menasha, Wis.
Rohtas Industries Ltd., Dalmianagar, India
Royal Container Co., San Francisco, Calif.
Tasman Pulp & Paper Co. Ltd., Auckland, N. Z.

New Sustaining Members (1953)

During1953 the following companies have become sustaining members of the Technical Association:

Alrose Chemical Co., Providence, R. I.
Appleton Woolen Mills, Appleton, Wis.
Arabol Mfg. Co., New York, N. Y.
Cabot, Godfrey L., Inc., Boston, Mass.
Carpenter Steel Co., Alloy Tube Div., Union, N. J.
General Corrugated Machinery Co., Palisades Park, N. J.
Hygrotester, Inc., Brooklyn, N. Y.
Mixing Equipment Co., Inc., Rochester, N. Y.
Owens-Corning Fiberglas Corp., Newark, Ohio
St. Lawrence Starch Co. Ltd., Port Credit, Ont., Canada
Sandoz Chemical Works, Inc., New York, N. Y.
Sandusky Foundry & Machine Co., Sandusky, Ohio
Semet-Solvay Div., Petrochemical Sales, Allied Chemical & Dy Corp., New York, N. Y.
Swift, George W., Jr., Inc., Bordentown, N. J.
Tidewater Construction Co., Norfolk, Va.

Sulphur



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PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Bertram L. P. Anthony, Works Manager, Amber Chemical Co. Ltd., London, England.

Charles P. Bauer, Patent Counsel, Union Bag & Paper Corp., New York, N. Y., a 1930 graduate of New York University with a J.D. degree.

Henry E. Becker, Technical Director, Coos Bay Pulp Corp., Anacortes, Wash., a 1937 graduate of the University of Washington.

John M. Braithwaite, Factory Manager, Bowaters Fibre Drums Ltd., Brentwood, Middlesex, England.

Henri F. Brun, Technical Research and Technical Sales Manager, Societe des Produits du Mais, Paris, France, a 1930 graduate of Paris University.

Cyrus T. Brady, Quality Control Supervisor, Continental Paper Co., Ridgefield Park, N. J., a 1949 graduate of Columbia University.

Peter P. Byers, Supervisor, West Virginia Pulp & Paper Co., Covington, Va.

James D. Cahill, Jr., Assistant Manager, J. D. Cahill Co., Andover, Mass., a 1948 graduate of Tufts College.

Donald D. Carr-Harris, Assistant to the President, Sutherland Refiner Corp., Trenton, N. J., a 1934 graduate of Western Ontario College.

Stephen Chase, Jr., Production Manager, The Champion Paper & Fibre Co., Pasadena, Tex., a 1925 graduate of Dartmouth College.

Harland R. Clodfelter, Chief Chemist, Spaulding Pulp & Paper Co., Newberg, Ore., a 1934 graduate of Oregon State College.

Erik Dahlen, General Manager, Billeruds A/B, Saffle, Sweden, a 1916 graduate of the Royal Technical University.

Richard D. Deiniger, Plant Manager, Sall Mountain Co., Hamilton, Ohio, a 1947 graduate of Stevens Institute of Technology.

D. F. Donahue, Assistant Supply and Fiscal Officer, Research and Development Dept., U. S. Naval Powder Factory, Indian Head, Md.

Everett L. Ellis, Assistant Professor, College of Forestry, Idaho University, Moscow, Idaho, a 1941 graduate of the University of Washington.

P. Dean Graham, Jr., Technical Service Representative, E. I. du Pont de Nemours & Co., Inc., Newport, Del., a 1942 graduate of the University of Florida.

Bailey T. Groome, Plant Engineer, Austell Box Board Corp., Austell, Ga., a 1943 graduate of Duke University.

Norman W. Hansen, Chief Chemist, Fairfield Mill, Australian Paper Mfrs. Ltd., Melbourne, Victoria, Australia, a 1937 graduate of the University of Melbourne.

Willis G. Hartford, Assistant Production Manager, Champion-International Co., Lawrence, Mass., a 1929 graduate of Iowa State College.

William D. Haskin, Student, New York State College of Forestry, Syracuse, N. Y.

Dale G. Higgins, Plastics Engineer, The John Waldron Corp., New Brunswick, N. J., a 1928 graduate of Ohio State University.

Tibor Holzer, Director, Forschungslaboratorium Dr. Holzer, Zurich, Switzerland, a 1944 graduate of Federal Polytechnic Institute, Zurich.

Benjamin G. Hoos, Chemist, Brown Co., Berlin, N. H., a 1924 graduate of the University of Maine.

Robert R. Kindron, Research and Development Chemist, Buffalo Electro-Chemical Co., Inc., Buffalo, N. Y., a 1947 graduate of Canisius College.

La Veta N. Klein, Research Librarian, A. E., Staley Mfg. Co., Decatur, Ill.

Wayne H. Kuefner, Quality Control, Pioneer Div., The Flintkote Co., Los Angeles, Calif., a 1950 graduate of Iowa State College.

Eugene F. Landt, Packaging Technologist, U. S. Forest Products Laboratory, Madison, Wis., a 1940 graduate of Montana State University.

Leslie A. Lawrence, Manager, St. Anne's Board Mill Co. Ltd., Bristol, England, a 1935 graduate of the University of Bristol.

Emerson Lewis, Assistant Sulphite Superintendent, Eastern Corp., Lincoln, Me., a 1948 graduate of Bowdoin College.

Richard Lindenfelser, Chemist, American Cyanamid Co., Stamford, Conn., a 1938 graduate of Harvard University.

Robert C. Matthews, Test Supervisor, Chase Bag Co., Chagrin Falls, Ohio.

Charles J. Mayeux, Engineer, Gaylord Container Corp., Bogalusa, La., a 1937 graduate of Louisiana State University

Maurice J. Mazzetti, Special Agent, Brazil Export Corp., New York, N. Y. Attended Roubaisien Institute of Technology.

William A. McCoy, Chemist, Pacific Coast Paper Mills, Bellingham, Wash., a 1947 graduate of Seattle University.

Thomas N. McLenaghen, Control Superintendent, Abitibi Power & Paper Co. Ltd., Fort William, Ont., Canada, a 1947 graduate of Queen's University.

Herbert Moscowitz, Production and Maintenance Manager, Shelton Mfr. Co., Inc., Newark, N. J. Attended St. John's University.

Earl K. Murphy, Electrical Engineer, Rayonier, Inc., New York, N. Y., a 1934 graduate of Massachusetts Institute of Technology.

Samuel R. Nicholl, Vice-President, Modern Hard Chrome Service Co., East Detroit, Mich.

Richard W. O'Donnell, Shift Chemist, St. Regis Kraft Corp., Eastport, Fla., a 1948 graduate of Washington University.

Kenji Oishi, Managing Director, Toshin Paper Mfr. Co. Ltd., Matsumoto City, Negano Pref., Japan, a 1933 graduate of Kiriu Technical College.

Gunnar Ojermark, Mill Manager, Billeruds A/B, Jossefors, Sweden, a 1925 graduate of the Royal Technical University.

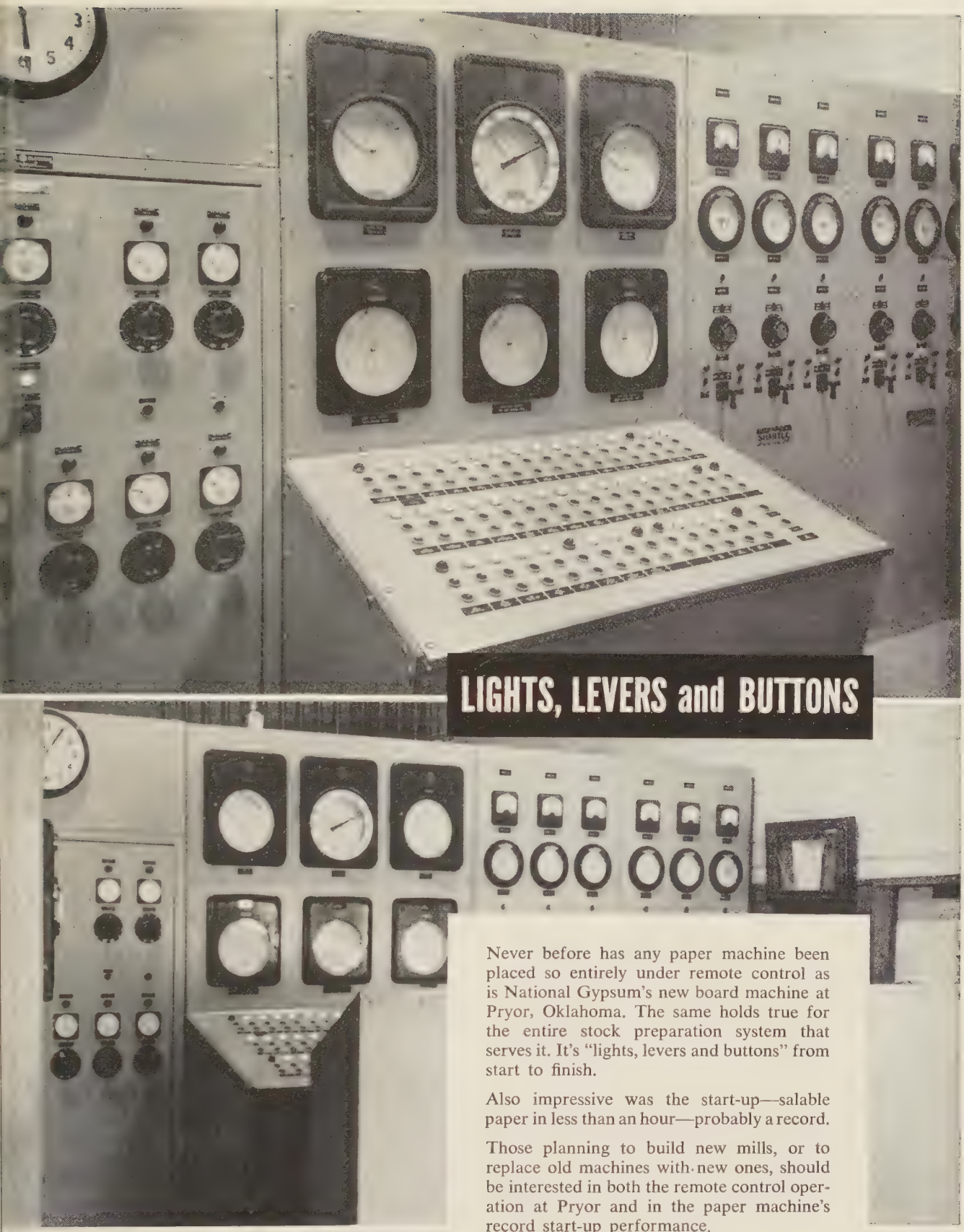
Bernard E. Proctor, Head, Dept, of Food Technology, Massachusetts Institute of Technology, Cambridge, Mass., a 1923 graduate of Massachusetts Institute of Technology with a Ph.D. degree in 1927.

John W. Ramsey, Superintendent of Paper Making, Champion Paper & Fibre Co., Hamilton, Ohio.

Walter E. Rice, Mills Manager, Canada Paper Co., Windsor Mills, P. Q., Canada, a 1920 graduate of Montreal Technical College.

Thomas N. Rider, Jr., Assistant Superintendent of Steam, International Paper Co., Ticonderoga, N. Y., a 1950 graduate of Clarkson College of Technology.

Robert L. Ringwood, Sales Engineer, Henry Pratt Co.



LIGHTS, LEVERS and BUTTONS

Never before has any paper machine been placed so entirely under remote control as is National Gypsum's new board machine at Pryor, Oklahoma. The same holds true for the entire stock preparation system that serves it. It's "lights, levers and buttons" from start to finish.

Also impressive was the start-up—salable paper in less than an hour—probably a record.

Those planning to build new mills, or to replace old machines with new ones, should be interested in both the remote control operation at Pryor and in the paper machine's record start-up performance.

Cylinder machines, Fourdriniers, Yankee machines, machine drives, calenders, reels, cutters, etc.

BLACK-CLAWSON

THE BLACK CLAWSON COMPANY • HAMILTON, OHIO

Chicago, Ill., a 1939 graduate of Carnegie Institute of Technology.

Allen A. Rylander, President, Canadian Permag Products Ltd., Montreal, P. Q., Canada.

McDewain Sandlin, Assistant Chemical Engineer, Gulf States Paper Corp., Tuscaloosa, Ala., a 1951 graduate of the University of Alabama.

Robert K. Scharmer, Box Laboratory Supervisor, Container Corp. of America, Philadelphia, Pa., a 1949 graduate of the University of Illinois.

Louis F. Schmerl, Assistant Superintendent, The Weston Paper & Mfg. Co., St. Marys, Ohio.

George R. Seviour, Technical Assistant, Production Dept., Canadian Resins & Chemicals Ltd., Shawinigan Falls, P. Q., Canada, a 1940 graduate of Nova Scotia Technical College.

Thomas Somerville, Chief Chemist, Wansbrough Paper Co. Ltd., St. Decuman's Mills, Watchet, Somerset, England, a 1939 graduate of Heriot-Watt College, Edinburgh.

Gordon M. F. Stick, Vice-President, F. X. Hooper Co., Inc., Glen Arm, Md., a 1926 graduate of Johns Hopkins University.

Herman Vogt, Mill Manager, Billeruds A/B, Slottsbrons Bruk, Slottsbron, Sweden, a graduate of the Technical University of Norway.

Gordon C. Abrams, Assistant Librarian, Serials Dept., University of Wisconsin, Madison, Wis.

Richard Waack, Student, New York State College of Forestry Syracuse, N. Y.

John H. White, Superintendent, Groundwood Div., Keyes Fibre Co., Waterville, Me. Attended North Carolina University.

Herbert W. Wilkinson, Jr., Sales-Service Engineer, American Aniline Products, Inc., New York, N. Y., a 1937 graduate of Lowell Textile Institute.

Stanley C. Williams, Chief Engineer, Paper Div., Dominion Engineering Works Ltd., Montreal, P. Q., a 1935 graduate of Queen's University, Kingston, Ont.

Robert S. Young, Assistant Superintendent of Manufacturing, Hammermill Paper Co., Erie, Pa.

Earl L. Youngren, Engineer, Helmick & Lutz, Minneapolis, Minn., a 1938 graduate of the University of Minnesota.

Robert H. Zinsmeister, Technical Superintendent, Kimberly-Clark Corp., Niagara Falls, N. Y., a 1942 graduate of the University of Wisconsin.

TAPPI Notes

Allen Abrams, Vice-President in Charge of Research of the Marathon Corp., Rothschild, Wis., was recently elected President of the Industrial Research Institute.

Fred L. Allen is now Vice-President and General Manager of the International Paper Co., Montreal, P. Q.

Kenneth A. Arnold is now Technical Director of the St. Regis Paper Co., Deferiet, N. Y.

Robert M. Babb, Mechanical Engineer for Merritt-Chapman & Scott Corp., has been transferred from New York City to Valdosta, Ga.

Harrison P. Baldwin is now Planning Engineer for the Hammermill Paper Co., Erie, Pa.

Thomas E. Bell of the Republic Flow Meters Co. has been transferred from Atlanta, Ga., to Chicago, Ill.

Howard J. Blake, formerly of the Wood Flong Co., is now Research Chemist for Case Brothers, Inc., Manchester, Conn.

Kenneth Bowers, formerly President of the Glens Falls Laboratory, Inc., is now Research Engineer for the Foxboro Co., Foxboro, Mass.

Francis O. Boylon, formerly of Pacific Mills Ltd., is now Assistant Resident Manager of Crown Zellerbach Corp., Camas, Wash.

Frederick T. Bradshaw, formerly Chief Engineer, is now Acting Manager of the Consolidated Paper Corp., Ltd., Grand'mere, P. Q.

Keith E. Bradway, formerly Student at The Institute of Paper Chemistry, is now Assistant Technical Director of the Camp Mfg. Co., Franklin, Va.

Edward T. Buchanen is now Acting Chief Engineer of the Consolidated Paper Corp. Ltd., Grand'mere, P. Q.

Leo S. Burdon is now Assistant Vice-President of the Scott Paper Co., Everett, Wash.

Robley A. Butler, formerly of Pacific Mills Ltd., is now Assistant Resident Manager of the Crown Zellerbach Corp., Port Angeles, Wash.

Mario C. Celli, Partner, Celli-Flynn, has transferred his engineering architecture office to 335 Shaw Ave., McKeesport, Pa.

William H. Chambers, formerly of the Reliance Electric and Engineering Co., is now with Louis Allis Co., Cincinnati, Ohio.

Harry K. Collinge, formerly of the Howard Smith Paper Mills Ltd., is now a Chemical Engineering Consultant in the Sun Life Bldg., Montreal, P. Q.

Dennis E. Cousins is now Vice-President of Hollingsworth & Whitney Co., Mobile, Ala., in Charge of Production in All Mills.

Charles E. Crawford, formerly of Bloomer Bros. Co., is now Chemist for the Fort Orange Paper Co., Castleton-on-Hudson N. Y.

A. H. Croup is now Manager of Laboratories, Hammermill Paper Co., Erie, Pa.

Fred E. Culp, formerly of the Consolidated Water Power & Paper Co., is now Group Leader, Paper Manufacture Research, Mead Corp., Chillicothe, Ohio.

Merrill Eldridge, formerly of Moore Business Forms, is now Manager of Technical Service for Warwick Wax Co., Sun Oil Co., Long Island City, N. Y.

Clarence A. Enghouse is now Assistant General Manager of the Crown Zellerbach Corp., West Linn, Ore. mill.

George H. Ferguson is now Vice-President and Treasurer of Alvin H. Johnson & Co., New York, N. Y.

Loren V. Forman is now Technical Director of the west coast mills of the Scott Paper Co., Everett, Wash.

Kristian Fougner, formerly of A/S Borregaard, is now with A/S G. Hartmann, Oslo, Norway.

Alexander Frieden is now Vice-President in Charge of Research for the Pabst Brewing Co., Milwaukee, Wis.

F. C. Gonzales, electrical Engineer for J. E. Sirrine Co., has been transferred from Greenville, S. C., to Calhoun, Tenn.

F. X. Guimond, Control Superintendent for the Canadian International Paper Co., has been transferred from Gatineau, P. Q., to Temiskaming, P. Q.

Hugo H. Hanson is now Chairman of the Board, W. C. Hamilton & Son, Inc., Miquon, Pa.

William R. Haselton, formerly Student at The Institute of Paper Chemistry, is now Technical Director of the Rhinelander Paper Co., Rhinelander, Wis.

Arthur H. Hupp, formerly of the Michigan Paper Co., is now with the Watervliet Paper Co., Watervliet, Mich.

Arthur W. Infanger, formerly of the Cowles Co., is now Assistant to the President in Charge of Research and Development of the Auburn Machine & Tool Co., Auburn, N. Y. and the Weedsport Mfg. Corp., Weedsport, N. Y.

Donald T. Jackson is now Director of Research and Development, Hammermill Paper Co., Erie, Pa.

Glen D. King is now Technical Director of the Crown Zellerbach Corp., West Linn, Ore.

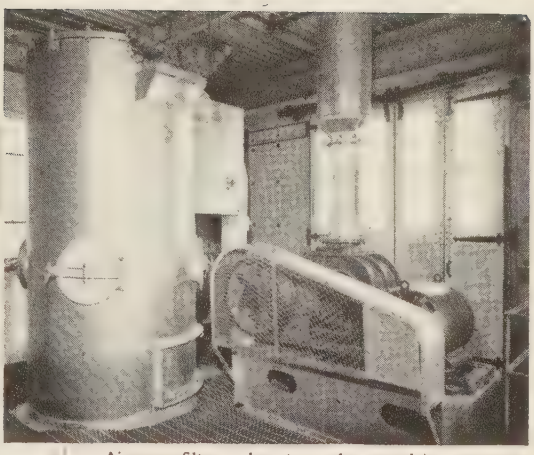
Paul R. Kinsey of the Union Bag & Paper Corp., Savannah, Ga., is now in the U. S. Army.

Robert E. Knowles of the Moraine Paper Co., West Carrollton, Ohio, has retired and will reside in Marlboro, N. Y. Mr. Knowles has been Superintendent of the Chemical Paper Mfg. Co., Nekoosa Edwards Paper Co., Paper Corp. of America, American Writing Paper Co., and the Hopper Paper Co.

ever consider MOVING chemurgics* BY AIR?

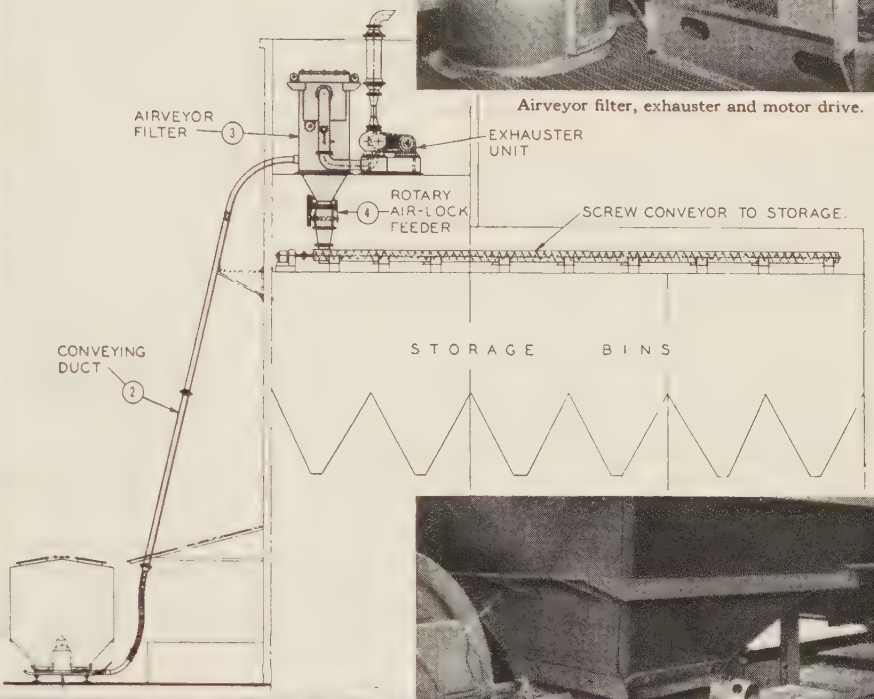
*(for example—starch)

The AIRVEYOR®

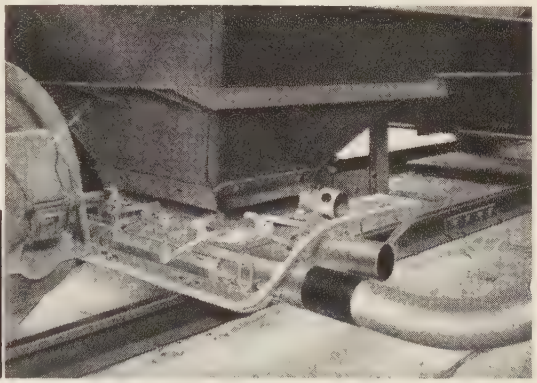


Airveyor filter, exhauster and motor drive.

Unloading starch from hopper car to plant. Flexible hose connection between twin-nozzle and conveying duct to Airveyor filter in the building.



it's Cheaper—Safer —More Efficient



Twin-nozzle arrangement for hopper-car unloading.

The Airveyor in your plant is like having the shipper deliver right to your storage bins. And it goes a step better than that! The Airveyor not only unloads and conveys from car to storage, but a flip of a switch delivers your material direct from storage to process. And while it's being efficient, it's also saving you money.

The Airveyor pays for itself in a relatively short time. It saves the difference in cost between bag and bulk shipment, and also lowers the cost of handling and storage. Labor costs are reduced because the Airveyor requires the attention of only one man. Important from the safety angle is the fact that dusting has been eliminated.

Maintenance time and costs are negligible because there are very few moving parts. The system can be blown clear of all residue. Retention of all visible dust is assured.

Installation of this better method of handling starch, soda ash, lime, salt cake, clay, or other dry pulverized materials will prove of great advantage to you. Why not consider Airveyor's possibilities in your plant? Without obligation, a Fuller engineer will analyze your present conveying system and show you how the Airveyor can help in your operations.

Fuller

DRY MATERIAL CONVEYING SYSTEMS
AND COOLERS—COMPRESSORS
AND VACUUM PUMPS—FEEDERS,
AND ASSOCIATED EQUIPMENT

FULLER COMPANY
Catasauqua, Pennsylvania
Chicago 3—120 So. LaSalle St.
San Francisco 4—420 Chancery Bldg.

A-124

William F. Long of the International Business Machines Corp. has been transferred from Endicott, N. Y., to San Jose, Calif.

John T. MacDonald, formerly of Provincial Paper Ltd., is now Engineer for the Ontario Paper Co., Thorold, Ont.

Donald P. McNelly, Quality Control Engineer of the Fort Wayne Corrugated Paper Co., Hartford City, Ind., has been transferred to Rochester, N. Y., as Plant Manager.

Milton J. Maguire, recently retired from the Hercules Powder Co., is now a Manufacturers Agent, 2175 N. W. Irving St., Portland 10, Ore.

W. D. Maxim, Division Manager of the International Paper Co., has transferred his office from Palmer, N. Y., to Glens Falls, N. Y.

Burt Mendlin is now Assistant Production Manager of the Container Div., Cornell Paperboard Products Co., Milwaukee, Wis.

Walter C. Miller of the Coos Bay Pulp Co. has transferred from Anacortes, Wash., to Empire, Ore., as Plant Engineer.

William A. J. Mitchell, President of Central States Engineering, Inc., has transferred his office in Appleton, Wis., to the Conway Hotel Bldg., 128 N. Oneida St.

K. Nadarajah is now Assistant Engineer, Planning Div., Dept. of Industries, Government of Ceylon, Colombo 2, Ceylon.

Kurt C. Neuenfeldt is now Development Engineer for the Hammermill Paper Co., Erie, Pa.

Edward H. Nunn is now Assistant to the Resident Manager of the Crown Zellerbach Corp., West Linn, Ore.

C. P. Olstad, formerly of the Johnson Foil Mfg. Co., is now Technical Director of the Waxide Paper Co., St. Louis, Mo.

S. R. Parsons is now Research Supervisor of the Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.

Mark Plunguian, formerly of the Celanese Corp. of America, is now Director of Research for Southern Chemical Cotton Co., Chattanooga, Tenn.

Thomas E. Powers, Technical Service Engineer of the Hercules Powder Co., has been transferred from Atlanta, Ga., to New Orleans, La.

Shafiquer Rahman, formerly Student at the New York State College of Forestry, is now Research Assistant in the Chemical Laboratory of the University of Dacca, Dacca, East Pakistan.

Royal H. Rasch is now Research Section Head of the Hammermill Paper Co., Erie, Pa.

Howard S. Rish is now Manager of Production for the American Coating Mills Div., Robert Gair Co., Inc., Elkhart, Ind.

Frank W. Roberts, formerly Chief Engineer of the S. D. Warren Co., Cumberland Mills, Me., is now Mill Manager of the Central Paper Co. Div., S. D. Warren Co., Muskegon, Mich.

Robert G. Ruark of the Corn Products Refining Co. has been transferred from Argo, Ill., to New York City as Executive Assistant to the President.

William B. Scott is now Assistant to the Vice-President in Charge of Manufacture, Consolidated Paper Corp. Ltd., Grand'mere, P. Q.

Eric R. Smith is now President of Alvin H. Johnson & Co., New York, N. Y.

Dudley H. Smith, formerly of Hollingsworth & Whitney Co., is now Project Manager, Research Div., Keyes Fibre Co., Waterville, Me.

Richard L. Snideman is now Consultant to the Management, American Coating Mills Div., Robert Gair Co., Chicago, Ill.

George E. Soyka, formerly of the Fort Orange Paper Co., is now Technical Director of Byron Weston Co., Dalton, Mass.

Conrad Steen, formerly of the Beloit Iron Works, is now Paper Engineer, Embretsfos Paper Mills, Amot in Modum, Norway.

Howard Stevens is now Plant Engineer of the S. D. Warren Co., Cumberland Mills, Me.

Gerald L. Swope is now Manager of Paper Container Research for the Continental Can Co., Van Wert, Ohio.

Robert I. Thieme, formerly Technical Director of the Soundview Pulp Co. Div., Everett, Wash., is now Plant Manager of the Scott Paper Co., Anacortes, Wash.

James S. Thornton, formerly Sales Engineer for the Downingtown Mfg. Co., has joined John V. Roslund, Manufacturers Representative for the Asten-Hill Mfg. Co., Downingtown Mfg. Co., and H. Waterbury & Sons Co., Portland, Ore.

John C. Tongren is now Process Development Associate for the Hammermill Paper Co., Erie, Pa.

V. Edwin Ware, formerly of the Marathon Corp., is now Plant Manager of Doeskin Products, Inc., Wheelwright, Mass.

James E. Watson is now Vice-President and General Manager of the Wisconsin Wire Works, Appleton, Wis.

James H. Wing, formerly of Hollingsworth & Whitney Co., is now Physicist for the American Optical Co., Southridge, Mass.

Christopher C. Wright, formerly Manager of the Paperboard Div., Minas Basin Pulp & Power Co. Ltd., is now with Case Bros., Inc., East Hartford, Conn.

* * *

Trundle Associates, Inc., has moved from 1501 Euclid Ave. to 2020 Carnegie Ave., Cleveland 15, Ohio.

Combustion Engineering-Superheater, Inc., New York, N. Y., has changed its name to Combustion Engineering, Inc.

* * *

Members of the Technical Association who may be planning to change their addresses are urged to notify the Association prior to making such moves. In a number of cases this advice has been received too late to take care of current mailings, with the result that copies of *Tappi* and other mailings have been returned to the publisher and have had to be remailed to the new addresses.

Industry Notes

Production

Paper and paperboard production in March amounted to 2,254,000 tons, bringing the total production for the first three months to 6,524,415 tons (annual rate of 26 million tons), the third best quarterly period in the experience of the industry. The principal factor in this achievement was the high volume of output by paperboard and building board mills. The paperboard production at three million tons was 16% higher than for the same period in 1952 and approximately equal to production during the first quarter of 1951. Production of building board amounted to 356,000 tons and was 24% higher than during the first three months of 1951 and 1952.

In the printing field over-all production at 891,000 tons was only 2% below production during the first quarter of 1952, and slightly higher than the same period in 1951.

Fine paper shipments in the first quarter of 1953 was lower than for the same period in 1952 but better than the average rate for that year. Commercial demand has continued to be excellent but the fine paper industry has experienced a considerable decline in the demand for paper from the United States Government and a sharp reduction in the overseas demand for fine paper. In 1952 the Government and export demand represented 12% of the total; currently it is no more than 5% of the total.

Production (tons) in first quarter (1953):

Printing papers	891,213
Fine papers	310,544
Coarse papers	842,000

DON'T LET WINTER ROB YOU OF PROFITS!

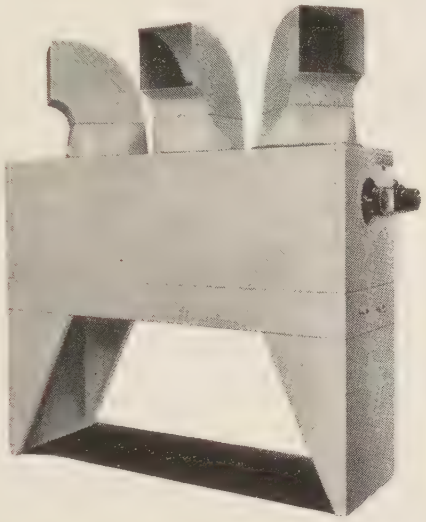
ADVANCE WEATHER FORECAST
Mercury to Drop to Zero.
COLD GRIPS CITY

NOW'S THE TIME TO INSTALL "Buffalo" UNIT HEATERS

Winter can put the "chill" on your plant and people, cutting down production, efficiency, and profits! Why take the chance? "Buffalo" Unit Heaters warm up hard-to-heat corners and areas—at low cost. Compact "Buffalo" heaters are easily and quickly installed. So right now, while it's hot, make sure it's warm in your plant next winter!—Install "Buffalo" Unit Heaters!

BREEZO-FIN

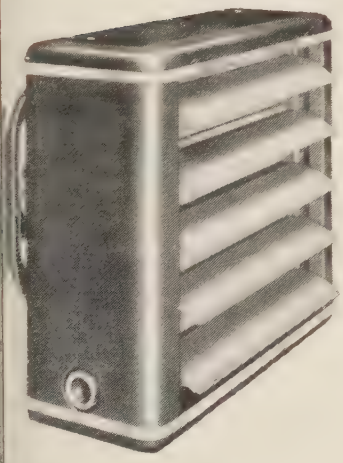
"Buffalo" Breezo-Fin Heaters deliver comfortable heat in small areas and operate economically on as little as 2 lbs. steam. Available in 20 sizes; have high-quality Aerofin heater element for maximum radiation and "Buffalo" Breezo Fan to throw heat positively. Write for Bulletin 3137.



HIGHBOY

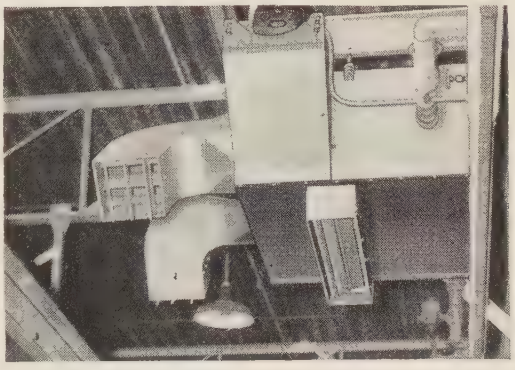
The Highboy is ideal for heating that "new addition" or any large area.

Highboy is easily adapted to your present heating system, since it has adjustable outlets for duct connections and louvers. Unit pictured has "Buffalo" non-corrosive Aerofin heater element and mixed-flow fans on hollow shaft. "Buffalo" can supply arrangements and combinations tailored exactly to your individual needs. Write today for Bulletin 3704.



NO WASTED FLOOR SPACE WITH LOW-BOY!

This suspended model supplies fresh, warm, filtered air to an entire room. In addition to its high-efficiency non-corrosive Aerofin heater element, it has "Buffalo" mixed flow fans on hollow shaft. When used as a window installation, it supplies makeup air for plants using large capacity exhaust systems.



FIRST FOR FANS

BUFFALO FORGE COMPANY

528 BROADWAY BUFFALO, NEW YORK

PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING
FORCED DRAFT COOLING HEATING PRESSURE BLOWING

Tissue papers	371,714
Miscellaneous papers	139,265
Newsprint	263,936
Building papers	284,471
Paperboard	3,064,747
Building board	356,155
Total	6,524,415

January and February wood pulp production amounted to 2,816,000 tons. Consumption amounted to 3,004,000 tons. Exports were 21,000 tons, a decline of 46% from the 1952 level. Total imports were 359,824 tons, an increase of 6% over the first two months of 1952. Imports from Canada of 239,088 tons were a decline of 15%, while imports from Europe of 120,736 tons were an increase of 109%.

Wastepaper

Paperboard mills during January and February consumed 77.4% of all of the wastepaper consumed in the United States. The total consumption amounted to 1,390,527 tons of which the board mills consumed 1,076,039 tons.

In both mill purchases and consumption, the news grades led the wastepaper parade in April, with the mills purchasing 103% of their current requirements. There were losses of less than 1% in both mixed and container grades, and the mill purchases of high grades broke even with consumption. Inventories were not appreciably increased at the mills.

A few weeks ago, when the New York *Herald Tribune* reduced the size of its pages by 1 in. in width, and it became known among the wastepaper industry that hundreds of other newspapers throughout the country had done likewise, some fear was expressed by some of the wastepaper suppliers that this might result in future shortages of the news grades of paperstock. This feeling now seems to have been dissipated because, instead of consuming less newsprint, a great many of the newspapers are using more than formerly. According to the American Newspaper Publishers Association, newsprint consumption in the United States during the first quarter of this year amounted to 1,472,061 tons, an increase over the first quarter of 1952 of 2.3% and an increase over the first quarter of 1951 of 3.9%. The ANPA newspapers, which use 76% of the nation's total consumption of newsprint, in March consumed 420,956 tons, which was substantially more than during any of the previous 38 months with the exception of last October, when 425,981 tons were consumed.

At the present time, there appears to be no shortage of any grade of wastepaper. There is a tremendous amount of wastepaper that is not being collected, but the collections are providing sufficient to meet mill requirements.

Only twice in the last 8 years since the end of World War II have the Eastern mills purchased and consumed more wastepaper than they have during the first 4 months of this year. Of course, one of those years was in 1951, a pinnacle in wastepaper consumption. The other was in 1948, when mill purchases were 2% higher and consumption 3% higher than during the 4 months just ended.

While we seldom hear about them until they come into the market, many new uses for paper and paperboard made from wastepaper are being developed. For instance, one of the recent developments of the Container Corporation of America, is a new type of a corrugated shipping container that makes possible the handling and shipping of flour in one-ton lots. It is said that this new container substantially reduces packaging, storage and labor costs compared with the old method of shipping flour in 100-lb. bags. From the Far West, we hear of a new type of apple boxes being developed for Pacific Coast shippers, in which paperboard liners are laminated to a low-grade wood base. However, new fiber boxes also are being developed and put into use for Western fruit and vegetable shippers.

Facilities Under Way (1952)*

American Reinforced Paper, Tracy, Calif., $527,000. Paper products. Contract awarded.

Anacortes Veneer, Anacortes, Wash., $1 million. Hardboard. In production. Uses new semiprocess.

Bowater's Southern Paper, Charleston, Tenn. $15 million. Sulphate pulp and newsprint. Contract awarded. Plant to be on Hiwassee River.

Crown Zellerbach (Western Waxed Paper), San Leandro, Calif. $350,000. Paper products. Contract awarded. Expansion.

East Texas Pulp & Paper, Jasper Co., Tex. $2 million. Pulp and paper. Newly formed company. Capacity: 90,000 tons paper per year

Everett Pulp & Paper, Everett, Wash. $2 million. Pulp and paper. Contract awarded. Plant addition.

Great Northern Paper, Millinocket, Me. $6 million. Pulp and paper. Proposed kraft mill.

Oxford Paper, Rumford, Me. $500,000. Bleached pulp and paper. Proposed five-story bleachery.

Pollock Paper, Dallas, Tex. $304,000. Paper products. Contract awarded.

Procter & Gamble (Buckeye Cellulose), Foley, Fla. $20 million. Pulp (dissolving and nitrating). Pulp mill under construction.

Rayonier, Jesup, Ga. $25 million. Chemical celluloses. Building mill primarily for rayon. 87,000 tons per year.

Rhinelander Paper, Rhinelander, Wis. Semichemical pulp. Building started on 40 tons per day semichemical pulp plant; will use aspen.

St. Marys Kraft, St. Marys, Ga. $1,350,000. Proposed additions to sulphate pulp mill.

Southern Paperboard, Port Wentworth, Ga. $5,600,000. Paper products. Additions to plant.

Southland Paper Mills, Lufkin, Tex. $15,050,000. Paper. Proposed new mill.

West Virginia Pulp & Paper, Covington, Va. $100,000. Paper products. Contract awarded. Plant additions.

New Technology (1951–52)*

Chemigroundwood pulp. (Mechano-chemical.) Uses hardwoods. Chemical cook of logs before grinding. Developed by Espra at New York State College of Forestry. Three pilot plants. One commercial plant.

Dissolving pulp. (Modified sulphate.) International Paper Co., Natchez, Miss. First plant for making dissolving pulp from hardwood. Plant operating January, 1951; capacity increased.

Dissolving pulp. (Kraft.) Logs chipped without debarking; bark separates during process. Developed by University of Florida; 3 tons per day; pilot plant planned.

Hardboard. (Resin binder.) Anacortes Veneer, Anacortes, Wash. Douglas-fir veneer waste is chipped, steamed, cooked ground, mixed with 1 to 3% resin, felted, pressed, and cured, all in semidry condition. Million dollar automatic plant turning out 90,000 sq. ft. 1/8-in. hardboard per day with 30 men.

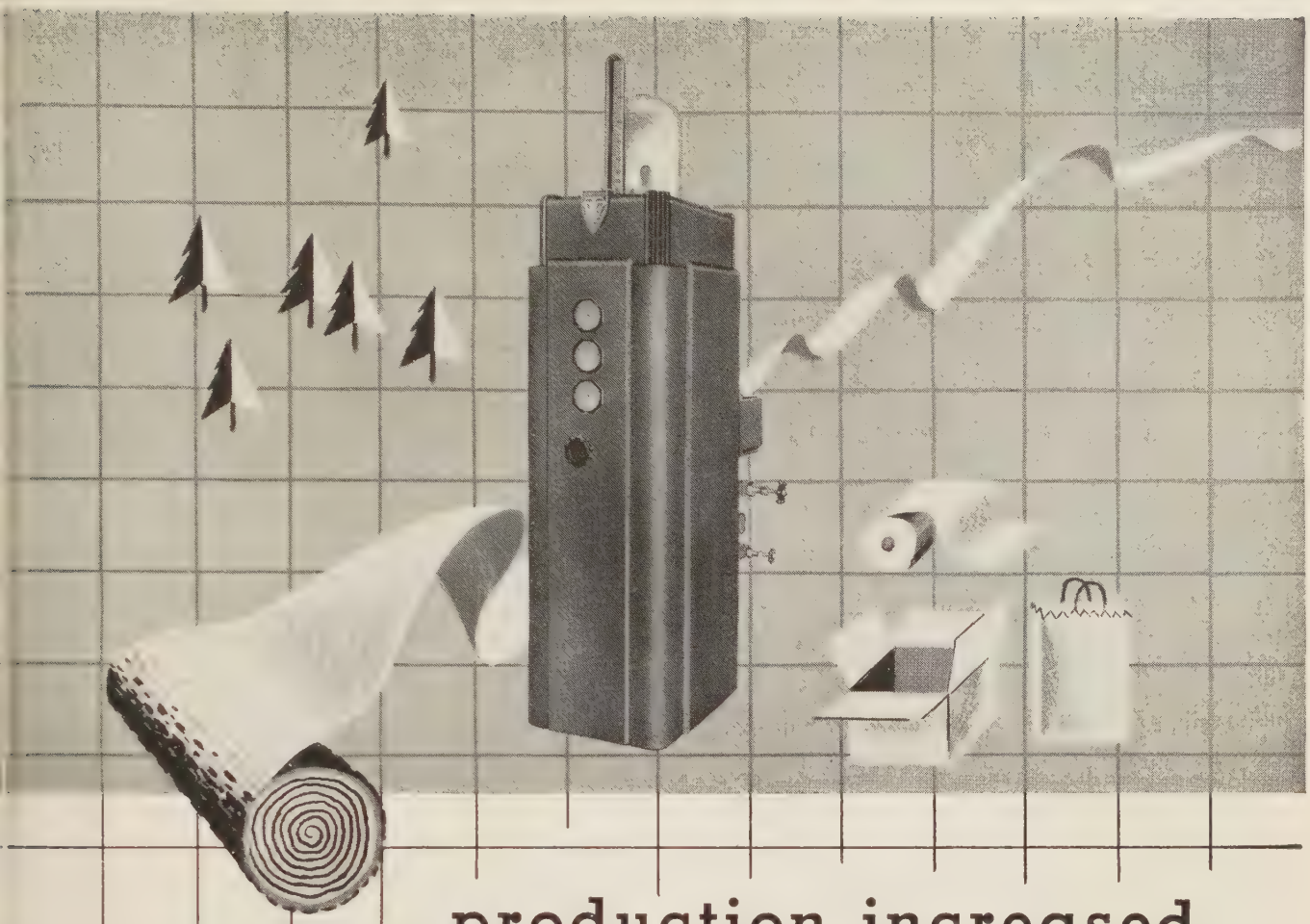
Hardboard. (Nonchemical.) Oregon Lumber Co., Dee, Ore. Requires less horsepower, by-passes debarking step, uses no chemicals. Uses waste Douglas-fir slabwood. $2.5 million plant in operation.

Kraft corrugating medium. (Semichemical.) Camp Mfg. Co., Franklin, Va. Deaeration and presoaking of chips used in a continuous process. Used in 50 tons per day plant.

Kraft paper. Made from mixture of southern pine waste wood and normal pine pulp.

Lignosol. (Concentration.) Lignosol Chemicals Ltd., Que-

* Reviewed by *Chemical Engineering*



production increased up to 15 tons per day...

. . . with W & T chlorination equipment

A Southern mill had been having trouble with paper breaks attributable to the presence of slime in their white water. Despite continued efforts to control them slime breaks were running 60 to 80 per week, resulting in a time loss of 10 to 14 hours per week, and an average production loss of 15 tons per day! It was then that the W&T man was called in. Where and how to apply the proper treatment was determined, the costly methods were discontinued, and W&T chlorination was installed.

During the first 3 days of chlorination the mill recorded only 1 slime break and 2 minutes of lost time.

During the next 3 days there were 4 breaks and 17 minutes of lost time.

During the next 25 days there were no breaks attributable to slime!

. . . Within a week there were no production losses caused by slime! Performance such as that is typical of what your W&T representative can do for you.

If you have a production problem attributable to impure water, it would pay you to write or call him now.

WALLACE & TIERNAN
COMPANY, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
NEWARK 1, NEW JERSEY • REPRESENTED IN PRINCIPAL CITIES

I-42

bec, P. Q. Concentrated lignin liquor or powder made from waste sulphite liquor. Plant under construction as of October, 1952.

Soda pulp. (Cold caustic digestion.) Green Bay Pulp & Paper Co., Green Bay, Wis. Chips soaked 2 to 3 hours in 2.5% NaOH at room temperature, drained, steamed, pulped in double dish refiner. Cycle requires 4 hours. Used as 1% stock. Being used as 25 to 60% mixed with semi-chemical pulp for making corrugating board.

Sulphate pulp. Continuous process eliminates prehydrolysis; pulp is satisfactory for viscose and acetate manufacture. Developed at University of Florida.

Sulphite pulp. (Evaporation.) Wastes from sulphite pulping concentrated in special nonfouling evaporator and burned. Developed by Kurt Rosenblad. Rhinelander plant in operation. Three other Wisconsin mills to use; equipped by General American Transportation Co.

Sulphite pulp. (Evaporation.) Lime in waste liquor crystallizes on bed of lime salts, eliminating fouling. Built by Struthers-Wells, trials conducted early 1952.

Sulphite pulp. (Ammonia pulping.) Crown Zellerbach, Lebanon, Ore. Wood cooked in ammonium bisulphite. Eliminates waste disposal problem. Commercial plant.

Sulphite pulp. (Lignin extraction.) Uses trimethylene glycol; gives more pulp, lignin by-product. Developed by University of Washington. Experimental use by Weyerhaeuser Timber Co.

Newsprint

The precarious balance between newsprint production and the growing demand will continue indefinitely, the National Production Authority, Department of Commerce has advised the Newspaper Industry Advisory Committee.

Newsprint production by United States and Canadian mills for the first 3 months of 1953 was virtually at capacity—1,665,670 tons against a rated capacity of 1,698,936 tons. Newsprint consumption in the U. S. now exceeds 6,000,000 tons annually, it is estimated. NPA officials pointed out that the present balance with production is partly due to efforts by newspaper publishers to cut roll sizes and to reduce newsprint usage.

Newsprint production in Europe and Japan will be restricted for a decade or more because of excessive forest cutting during World War II, NPA officials said. As a result, the United States may have to depend upon its own resources for increased newsprint supplies. Possible sources of additional newsprint include: (1) use of hardwoods in newspaper production (most newsprint is obtained from softwoods); (2) deinked paper, and (3) other pulp sources, such as bagasse, sugar cane pulp, etc.

A representative of the Forest Service, Department of Agriculture, told the publishers that Alaskan forests would support six major pulp and paper plants. The Tongass National Forest alone has 78 billion board feet of growth suitable for pulping, 75% of it within $2^1/_2$ miles of tidewater. High labor, fuel, and transportation costs may prevent immediate large-scale utilization of this pulping material, although one firm has applied for rapid tax amortization on a proposed newsprint mill at Juneau.

Representatives of the Office of Defense Mobilization cited the need for advance preparations to meet possible heavy damage to newspaper plants from enemy bombing. An NPA official pointed out that newspaper plants are generally concentrated within a small area in major cities. Newspapers in six cities—New York, Chicago, Philadelphia, Los Angeles, Detroit, and Washington—account for 35% of the newsprint consumed in this country, he added.

Milk Containers

The paper milk container industry in the United States set an all-time record by producing 8.5 billion containers during 1952, a 326% increase since the end of World War II; 38% of all milk sold for beverage purposes in 1952 was packaged in fiber containers.

Japan

The Japanese government has announced authorization for allocation of foreign exchange for $1,100,000 for paper pulp from the dollar area and open-account area (Finland and Sweden) under the April–September import budget.

China

The big state-owned Kwangtung paper mill in Canton, South China, is being reconstructed to make it one of the largest in China for the production of newsprint and pulp. This is the latest indication of the high priority being accorded to paper output under present Chinese plans for developing the industry. Pulp is now being made successfully in Szechuon from sugar cane stalks, a Soviet method being used and production is under the direction of a Soviet expert.

Portugal

A contract covering the building of a complete pulp and paper mill project for Portugal has been signed by Lyddon & Co., Ltd., London, for the Parsons & Whittemore-Lyddon organization.

The mill will be constructed for Celluloses do Guardiana, S.A., of Lisbon, Portugal, and work will be started during the next several months. The contract provides for the complete engineering, design, and equipment for a pulp and paper plant producing 25 tons daily. It includes a power and steam plant, as well as a paper and board converting factory. The mill is expected to be in operation within 2 years.

The raw material to be used, will be wheat or other cereal straw available in Portugal, together with small quantities of wastepaper and imported pulp.

The equipment for the Portuguese mill will be provided by the paper machinery companies affiliated with the Parsons & Whittemore-Lyddon organization—The Black-Clawson Co., Hamilton, Ohio, and Millspaugh, Ltd., Sheffield, England.

Drinking Cups

David F. Martin, traveling man of St. Paul, Minn., grew weary of drinking from poorly washed cups and glasses in restaurants. So he invented the paper cup in 1910. At one time he was collecting royalties at the rate of 5% on a gross of $2 million a year.

Paper Shipping Sacks

The Paper Shipping Sack Manufacturers Association, 370 Lexington Ave., New York 17, N. Y., has issued its General Manual No. 3, "Recommended Practice for Handling, Storage and Shipment of Material Packed in Paper Shipping Sacks."

Pollution

The California State and Regional Water Pollution Control Boards, Sacramento, Calif., has issued its WPCB Publication No. 5 on "Water Pollution Control" (1950–52). It is of value to companies interested in stream improvement.

Spruce Yield Tables

The Northeast Forest Experiment Station, Upper Darby, Pa., has issued a 64-page Station Paper No. 55, "Marinus Westvold's Empirical Yield Tables for Spruce-Fir Cut-Over Lands in the Northeast."

European Timber Statistics

The United Nations Food & Agriculture Organization, Geneva, Switzerland, has issued two large volumes, "European Timber Statistics (1913–50)" and "European Timber Trends and Prospects."

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Rayon

The International Rayon and Synthetic Fibres Committee will hold an International Congress of Man-Made Textiles in Paris on June 1–3, 1954.

Drupa

The next International Printing and Paper Fair (Drupa 1954) will be held in Dusseldorf, Germany, on May 15–30, 1954. The 1951 fair was attended by 300,000 visitors.

Public Printer

Raymond Blattenberger, Senior Vice-President of Edward Stern & Co., has been appointed Public Printer of the United States. He succeeds John H. Deviney who retired in February.

Safety

The Industrial Relations Committee of the American Paper and Pulp Association, in addition to its other responsibilities, is vitally concerned with safety and the record of the industry in the field of accident prevention.

In the years ahead the committee wishes to lay added stress on this phase of its activities with the aim of making the paper and pulp industry one of the Nation's safest industries. The industry's present record which is about average for all industry presents a challenge and provides considerable room for improvement. This statement is borne out by the following comparisons of frequency rates (the number of lost-time accidents per million man-hours worked) for several United States industries as reported by the Bureau of Labor Statistics for the year 1951:

Industry	*Frequency rate*
Explosives	3.4
Ordnance and accessories	6.0
Rubber	6.1
Auto manufacturing	6.3
Steel	6.4
Pulp, paper, and paperboard	15.8

In short, the Industrial Relations Committee feels that the pulp and paper industry can and should improve its record to rival the above industries which are leaders in terms of their safety records.

In addition to the humanitarian aspect of making the industry a safer one, there are other sound reasons for mills to improve their accident prevention record, among them being the following:

1. Accidents are expensive.
2. They retard production.
3. They create poor morale. (A low accident rate means better employee and public relations.)
4. If industry in general does not improve its experience, the very real possibility exists that some type of restrictive Federal legislation may be enacted which will create serious difficulties for industry to operate efficiently.

The foregoing reasons are but a few to impel mills to improve their safety record, but they should be sufficient to convince you of the need for an effective accident prevention program.

Following is such a suggested accident prevention program which has been designed by the Industrial Relations Committee to help those mills which do not now have one. You will note that it is flexible enough so that it may be fitted to your organizational plan. It is the hope of the Industrial Relations Committee that it may at least serve to stimulate some thinking and perhaps be the source of a new idea.

1. Company Safety Organization

The company safety organization should be under the direction of the executive manager of the company and function through a mill personnel or safety department. This organization should consist of:

The personnel supervisor and/or the safety supervisor
A general company safety committee
Plant and community nurses
Plant and/or community physician

In smaller companies, it may be necessary for the person responsible to the executive manager of the company for the safety program, to combine this duty with some other job. It is recommended, however, that safety activities be centered in one individual whether he can give his whole attention to these duties or whether he is involved in other responsibilities.

2. Company Safety Program

The program under which the mill safety organization should operate consists of the following general functions:

A. Participation by Management. It is recognized that in order for the safety program to function successfully, management must continue to maintain its interest, entire support, and participation.

B. Safety Director and His Function. It is recommended that a safety director—or a person to head up the safety program—be appointed. If the company is of such size as to make the employment of a full-time safety director impractical, a superintendent or department head may be assigned this function.

Listed as follows are some of the characteristics of a safety supervisor's job broken down into three general divisions:

Engineering Control

1. Analysis of accidents.
2. Determination of hazards and causes.
3. Inspection and maintenance of machinery and equipment.
4. Job analysis—for improved procedures.
5. Review of plans and specifications for new installations.
6. Elimination of hazards through change in design and layout.
7. Thorough investigation of all accidents.

Stimulation

1. Personal contacts with all employees to develop safe attitudes.
2. Special personal supervisory attention to careless employees.
3. Constructive supervision—helpful criticism.
4. Delegation of specific safety responsibilities.

Education

1. Proper placement and training of new employees.
2. Instruction in approved methods of operation.
3. Use of specific job instructions—written rules and regulations.
4. Posters, bulletins, contests, displays, warning signs, etc.
5. Short periodic meetings to discuss special problems and hazards.
6. Shop inspection committees on which all employees are rotated.

C. General Company Safety Committee. The establishment of a General Company Safety Committee, under the direction of the executive manager of the company is recommended with the personnel to be selected from:

Personnel supervisor
Safety supervisor—or person responsible for safety
Nurse
Physician
Plant engineer
Heads of departments

The purpose of this General Company Safety Committee is to make recommendations as appear to be necessary for the proper administration of the safety program.

Individuals may be appointed, or subcommittees may be formed, such as inspection committees, departmental committees, workmen's committees, and others as desirable in the opinion of the General Company Safety Committee.

The General Company Safety Committee should meet regularly at stated periods; not be subject to postponement,

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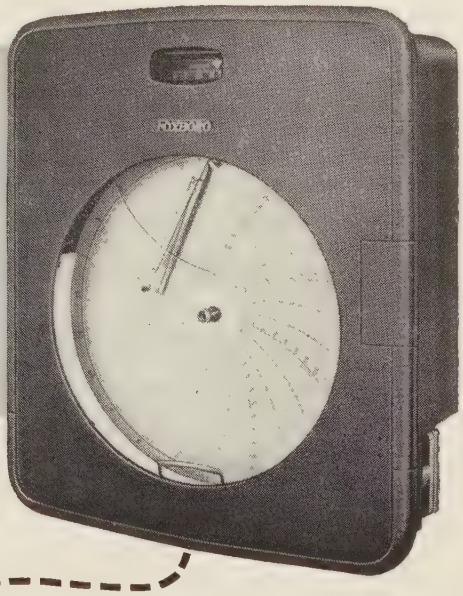

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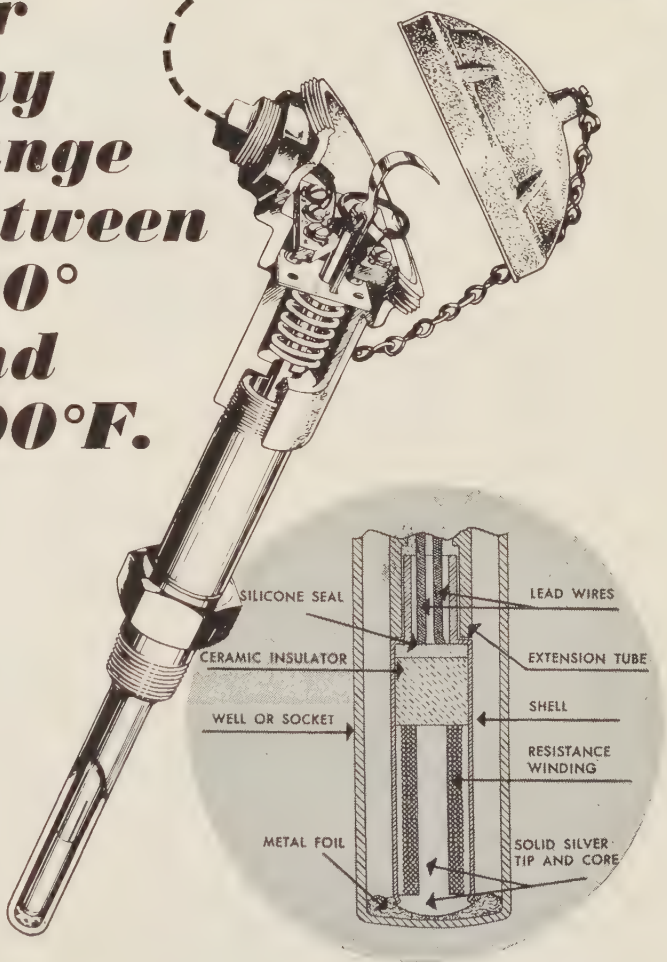

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and the meeting conducted on a previously developed written agenda.

D. Instruction of New Employees. The new employee, through an interview, should receive preliminary instructions with regard to the company safety program and safety policy. This can be supplemented by safety instruction booklets—printed safety rules, or other printed matter to emphasize the importance of safety to the new employee.

The new employee should be given particular instruction in how to perform his work in a safe manner. He should receive definite instructions from his immediate foreman—or from an experienced workman delegated by his immediate foreman—to acquaint him with the hazards of his job and how to avoid injury. This applies to employees transferred within the mill, as well as to employees newly hired.

E. Training of Supervisory Personnel. A program of training should be set up to familiarize supervisory personnel with specific unsafe acts and conditions that cause accidents. This can be based on the American Standards Association Code of Accident Causes.

Supervisors should also be taught the proper procedures in accident investigation methods.

F. Inspections. Regular inspections of the plant premises and the mill equipment should be made, to determine the need for, and the use of, safeguards or other corrective measures to overcome physical hazards.

Such inspections should be held at least once each month, and written reports of such inspection should be submitted to the executive manager of the company. Each department head should receive a list of such items as are involved in the operations or part of the plant under his supervision.

These inspections may be made by the safety supervisor, department heads, by a special inspection committee, or in whatever manner is determined will give the best results and maintain interest. Specific things to be checked would include: housekeeping, ventilation, lighting, unguarded machinery, floors, defective tools and equipment, etc.

G. Procedure for Correction of Physical Hazards. It is important that some definite procedure be set up so that after inspections are made and the results reported, a definite follow-up is instituted to see that hazards are corrected with a minimum of delay.

One other point that is considered highly important: Immediate acknowledgment should be given persons submitting recommendations.

H. Investigation of Accidents. It is suggested that a written report of an accidental injury requiring a doctor's care be made. The foreman of the injured man should make a personal and thorough investigation of the circumstances under which the accident occurred, at the scene of the accident. This is extremely necessary in order to determine a true history and cause of the occurrence, as well as to indicate what corrective measures need be taken.

I. Safe Operating Practices and Standards. It is necessary to establish safe operating practices and standards for employees working on specific jobs to follow to avoid accidental injury. The training of workers in safe operating practices and standards, and the enforcement thereof, is the responsibility of the foreman.

J. Protective Clothing and Devices. Goggles, respirators, safety shoes, etc., should be required on jobs where they are necessary for protection.

It is strongly recommended that any items such as goggles or respirators that are in personal use, be sterilized periodically and in no case should any such article, after being used by one employee, be issued to another employee before complete sterilization.

K. Reports and Statistics. Reports required by the safety program (reports of injuries; first-aid room reports; inspection reports; etc.) must be up to date, accurate, and contain complete information to be of value.

Statistics of industrial injuries should be provided for management review, and to act as a guide for future activities of the safety organization.

L. Safety Education. The features of employee safety education such as safety campaigns, contests, first-aid classes, posting of safety bulletins, movies, slide film demonstrations, and other similar activities, should be carried out under the direction of the person responsible for safety with the approval of the General Company Safety Committee.

3. Legislation, Regulations, and Codes

For the promotion of accident prevention by the Company Safety Committee, the person responsible for safety should:

A. Keep an up-to-date file of all state and Federal legislation pertaining to accident prevention.
B. Keep an up-to-date file on all codes and other regulations.
C. Keep an up-to-date file on all matters pertaining to accident prevention established within the mill including safety bulletins and established standard safe practices and rules.
D. Establish and maintain contacts with various agencies, such as your trade association; city, state, or Federal departments; organized safety agencies such as the National Safety Council, and such other contacts as may be necessary for the promotion of your safety program.

SWEDISH F.P.L.

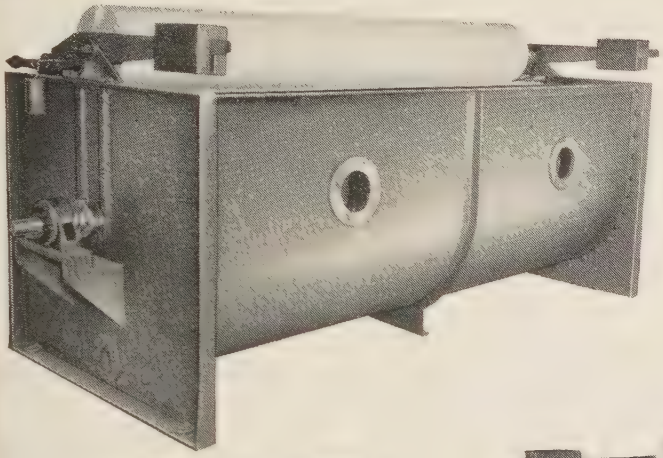
The forests are the backbone of Sweden's economy. Pulp, paper, timber, and hundreds of other products from wood account for about 50% of the country's exports. It therefore is no wonder that Sweden spends large sums and much effort on measures aiming at a highly rational utilization of the forest capital. Besides far-reaching steps for insuring the regrowth of the woods, an intensive research is carried on in official institutions and private laboratories for solving the many mysteries still hidden in wood and for developing new methods and new products.

Private industries and the government, aware that the best results can be attained by cooperation, established some years ago a large central institute in Stockholm, the Swedish Forest Products Research Laboratory, which has attracted attention far beyond Sweden's frontiers. It forms the headquarters for fundamental as well as applied research into all fields of wood chemistry and wood technology. Government and industry share jointly in the expense of maintenance.

The laboratory includes a whole complex of buildings situated in the "Science City," erected in recent years on the eastern outskirts of Stockholm. It comprises three departments for fundamental research, which are supported by the government—one for wood technology, another for wood chemistry, and one for paper technology. Moreover, there are a number of laboratories for applied research, financed by the organizations of the industries—the Central Laboratory of the Cellulose Industry, the Central Laboratory of the Paper Mills, the Central Laboratory of the Wood Pulp Mills, the Central Laboratory of the Wallboard Industry, and the Graphic Arts Research Laboratory. Applied research in wood technology is carried on in the department for fundamental wood research. The institution as a whole cooperates closely with the Royal Institute of Technology, which has its wood technical and chemical laboratories as well as lecture rooms within the buildings and employs at present about 50 university-trained research workers, in addition to some 130 assistants. The staff includes several noted Swedish scientists such as B. Thunell, wood technology; E. Hägglund, wood chemistry; and B. Steenberg, paper technology—all heads of their respective departments. Several prominent foreign scientists also are connected with the laboratory, and experts and students from other countries come there to work.

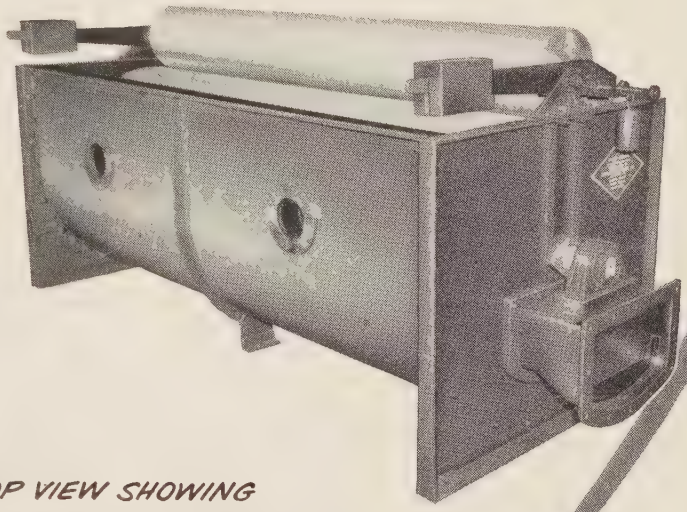
The Laboratory is complicated. There is an endless row of laboratories, small factories, instrument workshops, and storage rooms. In the paper department there is a giant KMW paper machine with a length of about 150 ft., with Yankee cylinders and various kinds of equipment and instruments required for experimental production of all kinds of

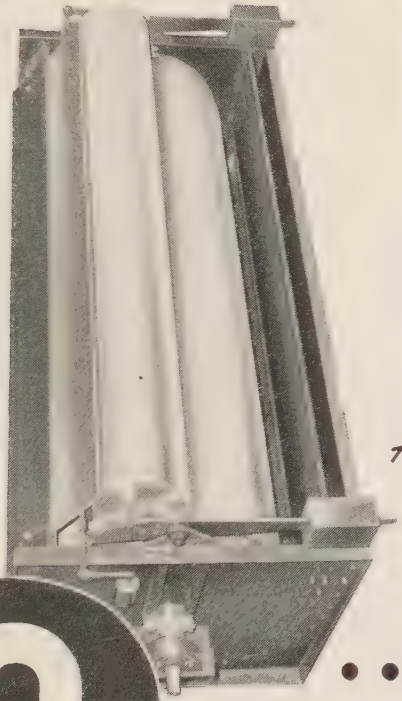
ANY WAY YOU LOOK AT IT...



VIEW OF END AND INTAKE SIDE OF COWAN DECKER

VIEW OF EFFLUENT DISCHARGE END FROM INTAKE SIDE





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paper and carboard. The speed can be varied from 30 to 1500 f.p.m. The plant also houses special "kitchens" for sizing and coloring experiments.

The other departments are just as well equipped. The cellulose industry laboratory houses all types of cookers from small electrically heated, 1-pt. autoclaves to cookers up to 300 qt., as well as hollanders, drying and bleaching apparatus. One department is devoted to experiments with rayon pulp and rayon fiber, the equipment including a spinning machine allowing stretching the fiber up to 72%.

The ground pulp laboratory is engaged largely in investigations of newsprint, for which purpose there is a complete plant, and the adjacent wallboard laboratory has at its disposal grinders, Asplund defibrators, and a complete wallboard machine producing sheets 25 in. wide. There is also a fan drier for the production of porous board, and a hot press for hardened board.

The wood technology department is located in a special building apart from the main laboratory, to avoid disturbing the rest of the institution with its noisy saws and other machinery. It has special sections for strength testing, drying, impregnation, and gluing, as well as a tool experimental department. The machinery constitutes a well-assorted exhibition of the diversified Swedish production of woodworking machines, well-known firms such as Jonsereds, Svenska Fläktfabriken, A. K. Eriksson, Carstens and many others having supplied the equipment. The same applies also to the other departments of the institution, which are predominantly equipped with machines and instruments of Swedish make, many of the latter designed and built at the Institute. There also is a large number of ultra-modern gadgets of foreign design.

The paper laboratory has many projects and the investigations include the analysis by means of punch card machines of strength figures from production at Swedish paper mills. In this manner 3-yr. statistics comprising about 100,000 primary values can be dealt with in a day and a half. Softening of paper by means of chemical compounds, and studies of the microflora of groundwood as well as the development of antibiotic substances are other investigations which seem to be of immediate practical value.

In wallboard production it has been possible to produce fireproof board through impregnation with superphosphate. There also has been developed a new standard for oil used in testing the fat density of paper.

Investigations show that the elasto-plastic qualities of wood change considerably when dried at high temperatures. Drying of pinewood has been carried out at temperatures of 70°C. without miscoloring and resin secretion, a considerable reduction in drying time being achieved.

Gluing and drying with high-frequency alternating current has been tried practically. By means of the electric method the time for gluing of skis can be reduced to 1 min., as against 10 min. by other modern methods. An extensive long-term gluing test program is carried on in cooperation with Swedish glue manufacturers. It will extend over a period of 5 yr. and will include regular investigations of indoor and outdoor test bodies.

Finally, the graphic arts research laboratory presents a most interesting link in the series of scientific bodies concentrated at this spot. Financed by the graphic research fund, which is supported by 200 firms, the laboratory was founded in 1942. It is equipped with a complete air-conditioned printing office.

Attisholz Yeast

Over in Switzerland, at Cellulosefabrik Attisholz (The Attisholz Pulp Mill), food yeast is being made successfully from waste sulphite liquor. The yeast is being grown in media which until a few years ago were considered partly unfermentable, and therefore unusable. Centrifugal machines play an important part in processing this valuable food yeast.

One of the basic materials used in making paper is sulphite pulp. When sulphite pulp is produced, one of the by-products is sulphite liquor, which formerly was discharged to a nearby river or stream. It was, in fact, usually called waste sulphite liquor. Sulphite pulp can be made from many kinds of wood, one of the favorites being spruce wood. Waste liquor from spruce wood contains about 3% reducing agents, consisting of approximately two-thirds hexoses and one-third pentoses. The hexose in the waste sulphite liquor has been used for years to make alcohol by fermentation. Pentoses, however, could not be used to make alcohol because pentoses were always thought to be unfermentable by yeast. For more than 30 years, at The Attisholz Pulp Mill, alcohol had been made by fermenting the hexoses of spruce wood sulphite liquor. During all that time the pentoses were lost.

Today food yeasts are being grown in media whose pentoses as well as hexoses can be used. This is an important development in the food industry, for such food yeast is a valuable animal food.

The Germans, during World War II, tried hard to develop a working process to make use of the pentoses lost in waste liquor. In one approach, they tried beech wood instead of spruce for beech sulphite liquor contains many pentoses. In another, they tried to use *unfermented* spruce wood sulphite liquor to make yeast, but, of course, when they used unfermented liquor it was not possible to recover the alcohol and alcohol was valuable.

During 1942, the chemical engineers at The Attisholz Pulp Mill wished to begin the manufacture of food yeast without abandoning their well-established production of alcohol. They found that when fermented sulphite liquor was freed of its alcohol content it still contained about 1% of pentoses. First in the laboratory, then in a pilot plant, and finally on a full-scale production basis, the Attisholz chemists developed a method of making food yeast from waste liquor pentose that proved very satisfactory. Today they obtain from 9.9 to 11.0 lb. of dry yeast from 35.4 cu. ft. of waste liquor, or roughly 1 lb. of dry yeast from every 25 gal. of waste spruce sulphite liquor.

The procedure is as follows:

The nutritive salts necessary for the yeast culture are added to the fermented waste liquor from which the alcohol has been freed. The refrigerated waste sulphite liquor with its 1% pentose is then fed into the so-called "fermenting apparatus." There, air is blown into the mixture transforming it into a froth with a specific gravity of about 0.3, and the yeast present in the frothy mixture starts propagating.

The process is completely continuous and can be carried on for several months without interruption.

The froth from the "fermenting apparatus" (and containing the propagated yeast) then is deaerated in special machines and subjected to further treatment. At this point it is extremely important to the quality of the final food yeast that the yeast be removed from the frothy liquid as *quickly as possible*.

The quantity of propagated yeast amounts to about approximately 0.5% dry substance when the content of pentose in the waste liquor is about 1%—a low concentration. Moreover, the yeast is difficult to filter well. Something more effective than filters had to be employed to make the separation.

De Laval separators, having a high capacity, were used. With them, a concentration of 1:10 was easily attainable, and they have the further advantage of being able to handle the liquid flow without the aid of any special pumps. The pumping action of the centrifuge is sufficient to convey the yeast-free liquid through an enclosed pipe line to the place where it is treated further.

The concentrate obtained after this initial centrifuging contains about 5% of dry yeast. It must be further concentrated, and this second stage of concentration is done in another type of De Laval separator. The 5% dry yeast is

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also water washed several times at this point in the process. When the yeast is discharged from the separator it contains about 15% dry yeast substance—a 30:1 concentration. It is ready to be dried and packaged.

Spruce Budworm

Attention of timberland conservationists the world over will be riveted on an all-out effort by Canadian pulp and paper interests to control the most feared of North American forests pests, the budworm.

Since 1949 the budworm population, particularly in the Canadian Province of New Brunswick has been increasing at an enormous rate. Thousands of acres of valuable spruce, pine and fir forests have been stripped and destroyed by the bud-eater, and thousands of additional square miles of timber are presently heavily infested.

Four of the big paper companies, in cooperation with the New Brunswick government, have taken the situation in hand. They have organized, for the mass destruction of bud worms, the greatest aerial spray operation in the annals of forestry.

Deadly DDT from the skies will blanket the selected area beginning on a May or early June day with appropriate weather conditions. DDT-Day for the bud worms will see 80 planes in action over more than 1,000,000 acres of forest. And before the job is done perhaps half a million gallons of insecticides will have been expended.

The area where the extermination of budworms is scheduled is a part of Upsalquitch watershed, in the north central part of New Brunswick Province, not many miles from the Maine state border.

In the 1952 experiment, Forest Protection, Ltd., bulldozed its first airstrip out of the wilderness, a 60-acre path. In the 1953 assault six such strips will be in operation to accommodate the fleet of 80 planes. All Winter and this Spring supplies, fuel, and equipment have been streaming in over the frozen New Brunswick roads to the scene of operations.

As the operational instrument, the paper companies have formed a nonprofit organization, Forest Protection, Ltd. Its pilot operation, carried out in 1952 over some 200,000 acres, was attended with such success that the greatly enlarged offensive of 1953 was mapped. As it proceeds, billions of budworms are doomed to die, and unmourned, say the men of F.P.L.

Vernon E. Johnson, President of New Brunswick International Paper Co., a division of International Paper Co., who is also Vice-President and General Manager of Canadian International Paper Co., commented on the project:

"In my judgment, no forest management undertaking in our time holds greater promise to Canada than this experiment endeavoring to pull an entire forest through an epidemic of a kind which might stagger the economy of an entire province or even Canada itself."

Mr. Johnson described the limited aerial forest spraying in 1952 as "impressive" in demonstrating the feasibility of treating large areas. "We still do not comprehend the natural forces which start and stop budworm epidemics, but we now know that DDT can be effectively sprayed from the air over vast timberlands and is a powerful weapon against the spruce budworm.

"We are certain that great numbers of trees in the area treated last year on the Upsalquitch watershed would have been doomed. They will be green again this year."

Dr. R. E. Balch, chief of the Dominion Entomological Laboratory at Fredericton, N. B., one of the leaders in the coming Battle of the Budworm, reported that in 1950 some 200 sq. miles of crown lands of the Upsalquitch watershed were denuded of foliage by the pests. In 1950 an additional 2200 acres were heavily infested and damaged.

The budworm, Dr. Balch explained, is vulnerable to spray only during a brief period in late May or early June when it is feeding. After the insects are fed to full size, they spin cocoons from which they will emerge as small brown moths.

Each female will lay up to 250 tiny eggs on the underside of pine, spruce, or fir needles. These eggs hatch in a few days and microscopic larvae—the next year's budworms—will emerge and spin a minute protective covering and prepare to wait out the Winter.

Budworm epidemics in former years, according to Dr. Balch, have been checked only when the insects had destroyed the trees on which they fed.

"How many budworms did we kill in the 1952 test? We killed almost all of them in the area treated," Dr. Balch declared. "Our observations after the spraying show that between 99.8 and 100% of the budworms on the plots at the time were killed."

Tall Oil

A. Scharwachter of Arizona Chemical Co., 30 Rockefeller Center, New York 20, N. Y., was re-elected President of The Tall Oil Association at its annual meeting in the Hotel Hershey, Hershey, Pa., April 16–19, 1953, it was announced recently from the Association headquarters at 122 E. 42nd St., New York 17, N. Y.

Artcher E. Griffin, Sales Manager of the Chemical Div., Camp Manufacturing Co., Inc., Franklin, Va., was elected Vice-President. Dernell Every continues as Secretary-Treasurer, and T. K. Heston as Assistant Secretary-Treasurer.

Among the ten items of business on a full agenda discussed by 15 members at the meeting conducted by the chairman, A. Scharwachter, was the admission to membership of the Crossett Chemical Co. of Crossett, Ark. This brings to 14 the number of manufacturers and sellers of tall oil in the trade association. Other members of the Association, formed in 1946, are:

Albemarle Paper Mfg. Co., Richmond, Va.
Arizona Chemical Co., 30 Rockefeller Plaza, New York City
Brunswick Pulp & Paper Corp., Brunswick, Ga.
Camp Manufacturing Co., Inc., Franklin, Va.
Champion Paper & Fibre Co., Canton, N. C.
Continental Can Co., Inc., Hummel-Ross Div., Hopewell, Va.
Gaylord Container Corp., 111 N. Fourth St., St. Louis, Mo.
National Southern Products Corp., Tuscaloosa, Ala.
Newport Industries, Inc., 230 Park Ave., New York City
North Carolina Pulp Co., Camden, N. J.
Southern Advance Bag & Paper Co., Inc., 38 Newbury St., Boston, Mass.
Union Bag & Paper Corp., Chemical Sales Div., 233 Broadway, New York City
West Virginia Pulp & Paper Co., 230 Park Ave., New York City

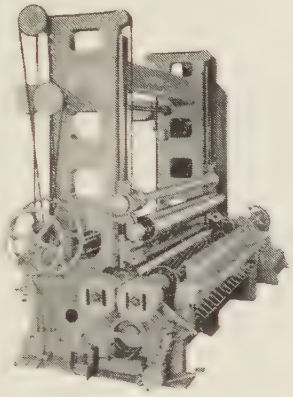
T. K. Heston, Assistant Secretary-Treasurer, reported that the 11-Tall Oil in Industry bulletins, published by the Association in individual form, have been consolidated and reprinted into a single booklet which will be available for distribution shortly. Topics of interest to the tall oil user which are contained in the new booklet are:

No. 1—Something About Tall Oil
No. 2—Tall Oil and Its Uses
No. 3 -Handling Tall Oil
No. 4—Tall Oil Testing Methods
No. 5—Tall Oil in Drying Oils
No. 6—Tall Oil in Soap Products
No. 7—Tall Oil in Core Oils
No. 8 Driers and Metallic Soaps
No. 9—Tall Oil in Emulsions
No. 10—Tall Oil Esters
No. 11—Tall Oil in Ore Flotation

Atomic Energy

Atomic energy to most people means atomic bombs and atomic warfare although the use of atomic energy for power production is also receiving some attention in the lay press. It is not generally realized, however, that the multi-million dollar expenditures on atomic piles and on nuclear research have given science its newest and perhaps its most powerful tool for nonmilitary research investigations.

LANGSTON
Slitters and Winders



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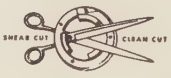


Some naturally occurring materials, such as uranium and radium, have been known for many years to be substances which are constantly giving off energy as they slowly change into other substances. These naturally occurring radioactive materials are exceedingly rare, exceedingly costly to obtain, and not always suited to the requirements of research. The atomic piles such as those at Chalk River in Ontario and at Oak Ridge in the United States have now made it possible for man to produce many new radioactive substances which are proving to be of very great value in such fields as medicine and industrial research. Radioactive cobalt metal, produced in Canada's atomic pile, is one of the most potent weapons known today in the fight against cancer.

The value of radioactive materials in industrial investigations depends to a great extent on the fact that they give off energy just as a hot substance gives off heat. Instruments have been built which are extremely sensitive to this radioactive energy and with which infinitesimal quantities of the radioactive materials may be detected. To give an example of the new tricks made possible by the use of these materials, let us consider the proverbial needle in the haystack. If the needle were made of a radioactive metal it could be found as easily as if it had a voice which kept on saying, "Here I am, here I am."

If a wood fiber is impregnated with a radioactive material it will be just like the talking needle and can no longer hide among other fibers but will be conspicuous to the sensitive detecting instruments. This furnishes a new technique for the study of pulp flow in the papermaking process.

Scientists at the Pulp and Paper Research Institute of Canada in Montreal were quick to realize the value of radioactive materials in pulp and paper studies and developed a method for treating pulp fibers with radioactive iodine. "Tagged" fibers of this kind were first used in 1950 at the Baie Comeau mill of the Quebec North Shore Paper Co. Here Institute technicians introduced a small amount of activated fibers into the pulp system just before the paper machine. By studying the paper produced they were able to learn new facts about the movement and the distribution of the fibers during the papermaking process.

In December, 1952, the Pulp and Paper Research Institute suggested that further experiments along these lines be conducted on the high-speed newsprint machines at Powell River. Mutually satisfactory arrangements were worked out and technical men from the Montreal Institute assisted by Power River Co. research laboratory technicians are conducting the experiment. As in the previous trials pulp fibers treated with radioactive iodine will be used. These will be injected into the pulp flows feeding two high-speed paper machines and will be incorporated into the finished paper with no interruption in normal operation. The amounts of radioactive material required are so small that no health hazard exists either in the making or the handling of the paper. The paper containing the activated fibers will appear normal in all respects but sensitive instruments will still be capable of locating the tagged fibers and in this way their behavior during the forming of the paper sheet from the wet pulp can be studied.

Additions of radioactive fiber will be made at several places in the machine headbox, the experiments being designed to study such important factors as the degree of mixing, the effect of flow rectifiers, and the behavior of the fibers on the paper machine wire.

It is felt that this radioactive tracer technique is one which may aid in the solution of many different pulp and paper problems and the Powell River laboratory staff is pleased to have this opportunity of learning how studies of this kind are undertaken.

Russian Translator

Regularly, the American Chemical Society gets hold of Russian reports on the Soviet pulp and paper industry, which it whisks to a Powell River Co. research chemist named John Keays with orders to read, digest, and interpret.

A man getting such intimate glimpses behind the Iron Curtain is rare, so I visited Keays at his office in Powell River, where he'd just finished "abstracting" the latest Moscow datelined essay. "Russian papermakers," he said, nodding mildly contemptuously at the black-bound, glossy-paper Russian volume without pictures, "are 10 to 15 years behind us."

He recited his arguments why. "Their fastest paper machines run 1200 ft. a minute," he said. Powell River averaged 1500-plus ft.

"The Russians are only now talking about artificial stones (used to grind pulpwood into groundwood pulp). We got into them 15 years ago.

"In organic chemistry," Keays said, "they are up to us. Their work on sulphite pulp could be taken right out of our current literature. But their stuff on actual paper production is out of our journals of 10 to 15 years ago."

Chance led Keays into his unique role. As a McGill undergraduate, he picked Russian language purely "on a whim." Today, he's big, influential American Chemical Society's (largest in the world) No. 1 watchdog on Soviet pulp and paper.

That makes him, boasts Dr. Ralph Patterson, Powell River Co.'s Technical Director, "the world's expert" on a Russian industry which has the resources, "timber, power, cheap labor" to make it potentially a tough export competitor of Canada.

So far, however, Keays assures his western world associates, "the Russians seem to worry mostly about what they'd like to do, not about what they've done. There was a long report recently describing paper machines they'd like to have—2000 ft. a minute, 90% efficiency."

Tree Plantings

Four out of every five trees planted in 1952 were set out on tax-paying land according to the annual planting report just released by the United States Forest Service. Tree planting in the United States set a new postwar high in the 1952 fiscal year with 522,935 acres planted.

Private plantings accounted for four fifths of the acreage reforested with 406,330 acres, followed by non-Federal public agencies with 62,777 acres and Federal agencies with 53,828 acres.

The forest industries alone, planted 144,829 acres in addition to giving millions of free seedlings to small timberland owners. Other industries such as mining, railroad, and water companies planted 19,592 acres.

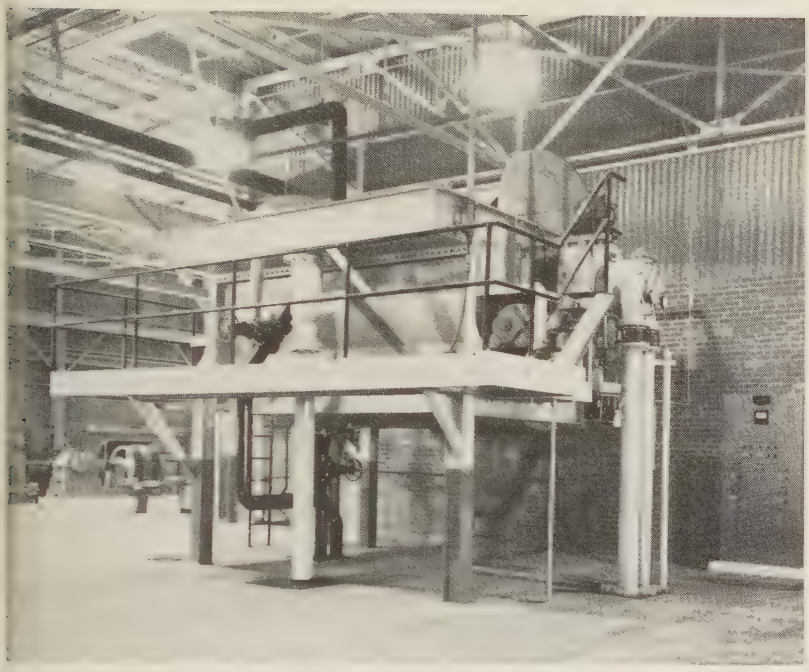
Georgia, with 50,338 acres, led all states in acreage planted, followed by: Oregon, 41,258 acres; New York, 41,216 acres; Louisiana, 36,740 acres; Michigan, 36,487 acres; Mississippi, 34,214 acres; and Florida, 29,078 acres. Oregon's acreage includes 6742 acres reforested by direct seeding.

Contract Packagers

The Second Edition of Packaging Institute's Directory of Contract Packagers and Their Facilities has been published by Packaging Institute, 342 Madison Ave., New York 17, N. Y., and is now available for purchase at $2.00 a copy. This 71-page book, $8^1/_2 \times 11$, gives full data about the packaging equipment and facilities of 81 contract packagers together with information about products that will be accepted or refused, and shipping facilities. A feature of this revised second edition of the Directory is a 15-page index by states to enable the reader to locate a possible contract packager with proper equipment in a given area without reading the entire volume.

All known contract packagers were questioned when the Directory was prepared and all who responded with the requested information have been listed and have received a free copy.

OLIVER SAVEALL



*Photograph courtesy
Certain-teed Products Corporation

Key Equipment In CERTAIN-TEED'S New Paper Mill

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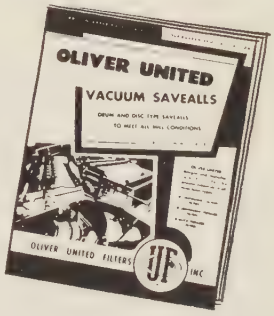
As a matter of fact, isn't it pretty nearly a must in every mill?

Oliver United, with its two unit selection, is the logical place to come for your Saveall requirements. One unit is the Oliver Drum Type Saveall, such as illustrated above and already in use in hundreds of mills. The other is the American Disc Type Saveall which provides special design and operating advantages, particularly in the handling of slow stocks such as tissues, book papers, highly refined pulps, carbon papers, glassine and light kraft. The American provides exceptionally large capacity for a single unit and because of this, is ideal for very large paper machines and certain high speed machines where excessive volumes of white water are involved. Several mills with special problems are now using it. Both Olivers and Americans are described fully in our Bulletin 701-R.



Yes, Oliver United is in position to give you *seasoned experience* in connection with fiber recovery problems and offers a choice of two well-proved Savealls — the Oliver and the American.

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The popularity of the Directory of Contract Packagers is attested by the fact that the first edition was reprinted three times. To the surprise of every one the principal purchasers of the Directory have been large companies that have large packaging facilities of their own.

N.Y.S.C.F.

Two graduate fellowships have been established at State University of New York College of Forestry at Syracuse (N. Y.) by the American Viscose Co., Marcus Hook, Pa. The grants, for $2000 each, are for basic research in the chemistry of cellulose and the technology of wood, according to an announcement by Dr. Edwin C. Jahn, associate dean for physical sciences and research.

First recipients of the awards are Edgar A. McGinnes, Jr., Philadelphia, Pa., and Robert W. Lenz, New York City. Both men are now enrolled as graduate students at the Syracuse forestry college.

McGinnes received his B.S. degree in 1950 and M.F. in 1951 from Pennsylvania State College. A 1949 graduate of Lehigh University, Lenz was awarded an M.S. in 1951 at the Institute of Textile Technology at Charlottesville, Va.

Western Michigan

An experimental calendering machine has been presented to the paper technology laboratories at Western Michigan College by Ward Wheeler of the Wheeler Roll Co., Kalamazoo.

Although it is a small-scale model, with some special features, it will operate at commercial pressures with rolls approaching commercial diameters. This is contrary to most laboratory calenders which will often not perform as do their big brothers.

The new calender at Western Michigan is located in a constant humidity room, giving opportunities for special experimentation. The paper roll on the machine has a 15-in. face and is removed endwise through the frame of the calender. This alteration was necessary due to lack of overhead space for maneuvering equipment.

Ward Wheeler, left, of the Wheeler Roll Co., Kalamazoo, and Robert Elias of the Western Michigan College inspect a sheet which has just come through the new experimental calender given to WMC by Wheeler and his firm

Despite the small face of the calender roll for this model, it is not the smallest manufactured by Wheeler, which reports it is now making rolls as small as $4^1/_2$ in. The largest made thus far is a 278-in.

Three prominent men in paper and the paper industry were recently honored with honorary memberships in T'sai Lun, a fraternity composed of paper technology students at Western Michigan College. Those mentioned were: E. T. A. Coughlin, chief of the paper and paper products unit, quartermaster corps of the Army; Olin W. Callaghan, Edgar Brothers, and Raymond Barton, Michigan Paper Co.

National Container

National Container Corp., one of the country's largest integrated manufacturers of kraft corrugated shipping containers has announced that it will open a converting plant in Memphis, Tenn.

T. T. Collins, National Container Corp.

According to Samuel Kipnis, President of National Container, the new Memphis converting plant will be in operation producing shipping containers within 60 days. It will be located at Provine and Neptune Streets.

A. Lee Gordon, Jr., who has been Manager of National Container's Memphis sales office, was appointed General Manager of the entire Memphis operation. A. Arthur Halle, Jr., will serve as Sales Manager.

The new converting plant will be the company's sixteenth in a coast-to-coast chain. In addition, National Container operates five kraft board, pulp, and paper mills and is now building a giant $25,000,000 mill near Valdosta, Ga.

T. T. Collins, formerly of the Thilmany Pulp and Paper Co., has been appointed Technical Director of the National Container Corp. at Jacksonville, Fla.

Gaylord

A new record for mass planting of pine seedlings by private industry has been announced by Gaylord Container Corp., Bogalusa, La., whose Louisiana and Mississippi holdings are believed to be the largest privately owned, man-planted forest in the world.

During the planting season just closed, Gaylord planted 18,630,000 seedlings on 24,770 acres in two states, a planting three times greater than the previous record of 7694 acres planted during the 1951–52 season. Gaylord has planted 98,843 acres since the program began in 1920.

Planting cost, according to Paul Garrison, Gaylord's chief forester, ran around $8–$10 an acre. About 80% of the planting was done by hand.

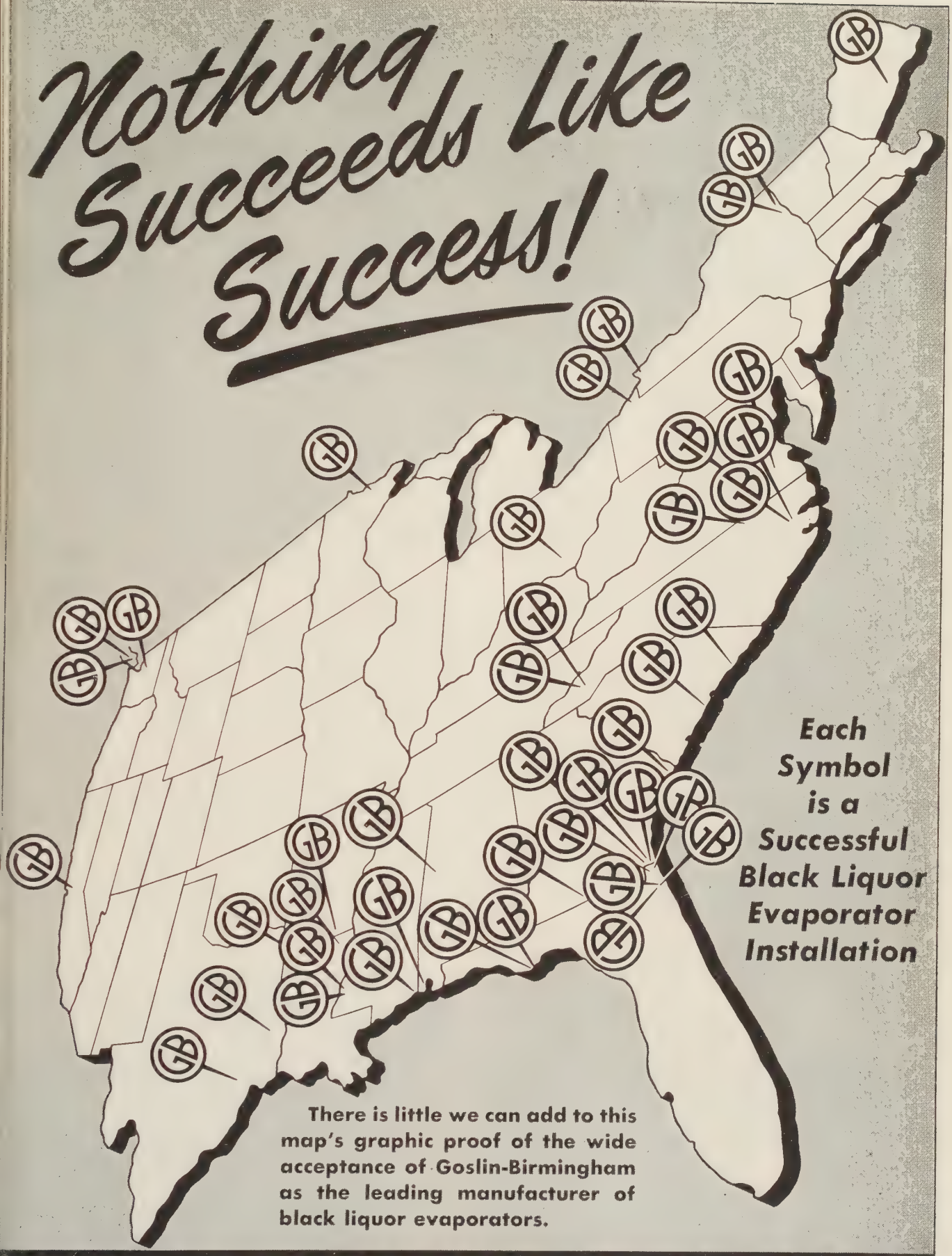
Seedlings came from Gaylord's own nursery at Morgantown, Miss., and from state nurseries at Kinder, La., Winona, and Mount Olive, Miss.

The firm, according to Mr. Garrison, plans to continue its annual planting program until all lands are adequately stocked with pine reproduction "and are thus brought back from a nonproductive state into a state of high forest production."

Mead

Just a year after ground was broken for its construction, the new Mead Research Laboratories were dedicated by The Mead Corp. in Chillicothe. Charles F. Kettering, a Mead

Nothing Succeeds Like Success!



Each Symbol is a Successful Black Liquor Evaporator Installation

There is little we can add to this map's graphic proof of the wide acceptance of Goslin-Birmingham as the leading manufacturer of black liquor evaporators.

GOSLIN-BIRMINGHAM MANUFACTURING CO., Inc.

BIRMINGHAM, ALABAMA

Miss Marianna Mead, youngest daughter of Geo. H. Mead, Chairman of the Board of The Mead Corp., opens valve which "blows" experimental digester symbolizing opening of new Research Laboratories as Russell H. Savage, Vice-president for Research, looks on

Director for many years, world-famous inventor, and former Vice-President of General Motors made the dedication address.

To symbolize the opening of the laboratories, Miss Marianna Mead, youngest daughter of Geo. H. Mead, honorary chairman of the board of the company, "blew" an experimental digester and began a series of experimental cooks on high-yield pulping. "High-yield pulping," Russell H. Savage, Mead Vice-President for research, explained in introducing Miss Mead and the dedication ceremony, "can be important to the economy of our company, and more, to the conservation of our forest lands. Beginning this new series of cooks is symbolic of the work we will undertake in our new laboratories."

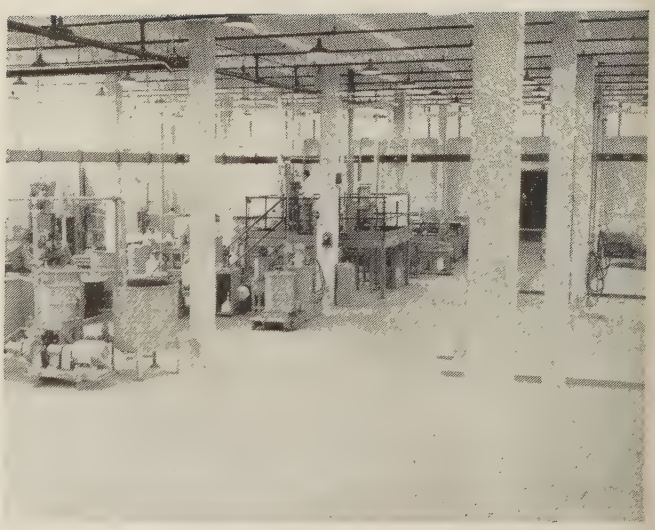
Directors and officers of the company and other distinguished guests made an inspection tour of the new facilities, which have been put into operation during the past month.

After the digester ceremony, Mr. Mead said that the new laboratory shows the company's appreciation to the group of men who, under Mr. Savage's leadership, have given the company some of its greatest successes. "The new setup," he said, "is an appreciation by The Mead Corp. of the loyal and wonderful service these men have rendered."

He then introduced Mead's "next oldest Director" in service, Charles F. Kettering. (Mr. Mead himself has the longest record of service on the Board of Directors.)

"Every time you build a new laboratory," Mr. Kettering

Exterior view of the Mead Research Laboratories



Part of the pilot plant showing experimental pulping and papermaking equipment

said, "you open new roads. Laboratories don't take the place of thinking, but when a laboratory is built around a definite objective, with the idea of solving specific problems, as this one is, its success is almost assured."

Mr. Kettering advised looking well into the future in research, digging into the "specifics" of a situation, and combining this theoretical approach with the tested values of experience and techniques developed throughout the years in the business. "The results of research must be economic, or they're not worth anything," Mr. Kettering said. "This laboratory will be successful if it helps improve the profit of the company."

Directors, other than company officers who attended the ceremony were Charles S. Cheston, Philadelphia, Director of Philco, Monsanto, and many other companies; Robert H. Lee, Drexel & Co., Philadelphia; E. T. Gardner, President of Gardner Board & Carton Co., Middletown, Ohio; and Mr. Kettering.

The Research Department has been growing steadily in recent years, and now numbers almost a hundred men and women. In the new location it will be possible to install needed additional equipment, and to permit greater efficiency in all phases of the work.

While located in Chillicothe, the Research Laboratories serve all divisions of The Mead Corp. The work is under the direction of R. H. Savage, Vice-President for Research, Rudolph Griesheimer, Director of Research, and John Redd and Edwin Flinn, Assistant Directors of Research.

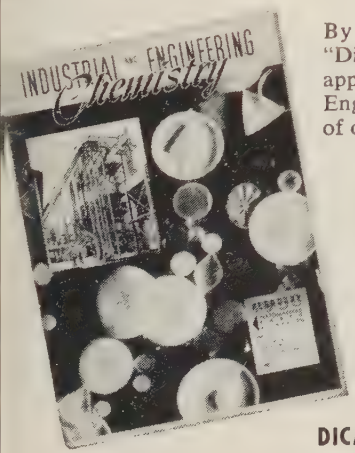
Four "outside" directors of The Mead Corp. watch a demonstration at the opening of the Research Laboratories. Left to right: E .T. Gardner, Charles S. Cheston, Robert H. Lee, and Charles F. Kettering

DICALITE Research and Development Work has *never* stopped

Dicalite's "inquiring mind"—with laboratories for tools—searches constantly for new and better ways in which Dicalite can serve industry. Even during the recent period when diatomaceous materials were in critically short supply, Dicalite steadily continued the research which had already made many contributions to industrial processing.

Look at the brand-new product pictured here—developed by Owens-Corning Fiberglas Corporation. It is a battery separator, made of Fiberglas, in which Dicalite serves so well as the filler because of its unique physical characteristics. This new product promises longer life for car and industrial batteries, since it is completely insoluble in battery acids. Dicalite engineers worked with the technical staff of the manufacturer, who is now using a specially selected Dicalite material which is a vital part of the separator composition.

The problem may just as well have concerned filtration, insulation, or any other Dicalite application. Constant research and development work is one strong reason why Dicalite can serve you better, not only in variety and quality of products but in dependability as well. Perhaps you have a problem or project where this service may be helpful. A Dicalite engineer will gladly call at your request.



By the way, have you seen the feature article, "Diatomaceous Earth," on Dicalite operations and applications in the February issue of Industrial and Engineering Chemistry? Write today for your copy of our free reprint to Dept.C-266, Dicalite Division.

ABOVE—This enlarged photo is a view looking at the edge of the new Fiberglas battery separator. On the right is the main portion made of a composition containing Dicalite, which affords two important advantages: extreme resistance to the acid, and high porosity. The special structure including the layers of glass fibers on each side, affords good strength and allows much more free circulation of the battery acid.

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Sheetmaking equipment in the pilot plant

The Laboratories are housed in two buildings on Eighth Street in Chillicothe, and cost close to a million dollars. A two-story brick office and laboratory building fronts on Eighth Street; offices line the north side of the building, with laboratories located across the corridor on the south side of the building. To the rear of the office, and at right angles to it, is the pilot-plant building, which houses the heavier experimental equipment.

The new buildings provide larger, better equipped, and more flexible laboratory and office space. Laboratories are piped for vacuum, steam, hot, cold, and distilled water, and gas, and are wired for electricity at 550, 220, 110 volts a.c. and 230 volts d.c. All laboratory air is exhausted outside, and fresh conditioned air continuously supplied.

The main building is two stories tall, with a full basement beneath. It is 166 ft. long and 54 ft. wide. Connected to it by a passageway is the pilot-plant building, a single-story, high-roof structure 150 ft. long and 102 ft. wide. The pilot plant encloses 15,630 sq. ft. of space, while the main building has 8980 sq. ft. on each story.

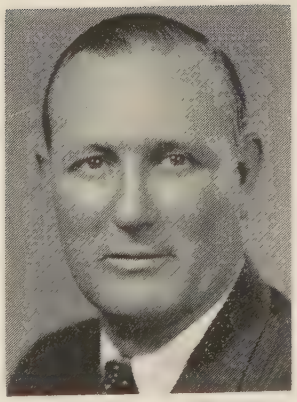
When you enter the main building from Eighth Street, you step into a lobby flanked on the left by a small conference room and on the right by a receptionist's and typists' office. A corridor leads directly to the rear, to the pilot plant and the freight elevator, and another traverses the building to give access to six offices along the front of the building (three in each wing) and four laboratories along the back (two in each wing).

On the second floor, space is provided for five offices and four laboratories, and two conference rooms which can be converted into a single large one by opening a pair of folding doors. At the east end of the second floor is the technical library. The building is of modular construction, and all laboratory walls and furniture are designed to be readily movable. Although eight laboratories are provided by the original layout, the same space can be readily made into as many as 21 by rearrangement of the walls and equipment.

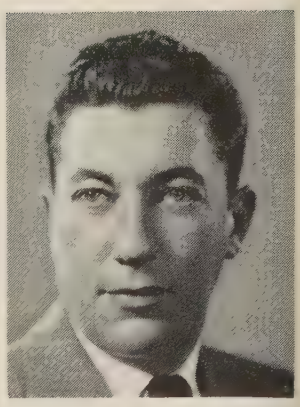
The basement houses storage rooms, shower rooms, air conditioning equipment, a photographic darkroom, a press room for testing the printing qualities of papers, two humidity rooms where temperature and relative humidity are controlled to make very accurate testing of paper possible, an optical testing room, a shop for making glass laboratory equipment, and a fireproof vault for storing records.

Interior of all laboratories and corridors is glazed tile, while office walls are plaster with wood wainscoting. Asphalt tile floors are used throughout.

The building was designed by Lorenz and Williams, architects, of Dayton, Ohio, in cooperation with the Mead staff. The Georgian style of the architecture is in harmony with the old Chillicothe architecture. It was built by the Maxon Construction Co. of Dayton, Ohio, under the supervision of Henry Young.



Andrew J. Miller, Jr., Mead Corp.



Hugh A. Black, Mead Corp.

Hugh A. Black has been appointed Director of Industrial relations for The Mead Corp. His promotion was announced at the Eleventh Annual Conference of Mead Executives and Mill Managers in Dayton, Ohio, May 5–7, by Howard E. Whitaker, president. Mr. Black will direct industrial relations activities under Andrew J. Miller, Jr., who was elected Vice-President for Industrial Relations at the Annual Meeting, April 28.

Ballarpur

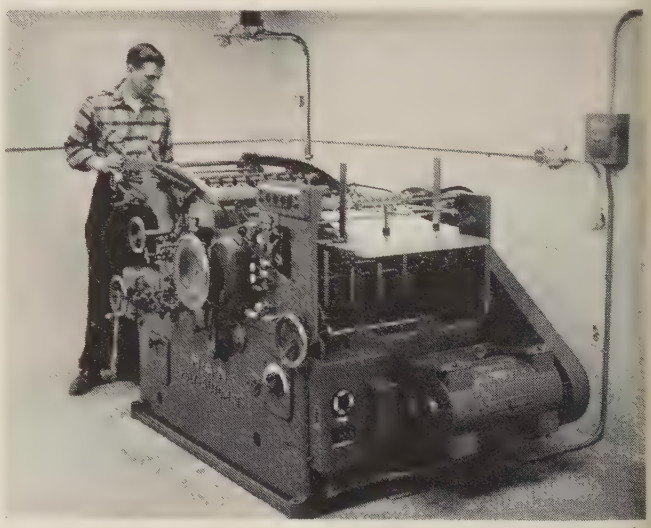
The Ballarpur Paper Mills located at Ballarpur in the Central Province of India will be going into production by the end of May.

The mill will be producing 25 to 30 tons of writing and printing paper per day using bamboo (*Dendrocalamus striclus*) as raw material. It will employ the sulphate cooking process of making pulp.

The machinery for this mill was supplied by John Inglis Co. Ltd. of Toronto (Canada). Erection work was carried out by an Indian staff under the direction of an Erection Superintendent, Brian V. Moss, whose services were made available by the John Inglis Co.

The starting-up operations will be carried out under the guidance of Roy D. Rivers, who has started several mills in U.S.A., Brazil, and Peru.

The management of the mills is in the hands of Karam Chand Thapar & Bros. Ltd. who also own and operate the Shree Gopal Paper Mills in Punjab (India).



Poly-Automat press installed in the experimental printing department

Toppila Groundwood Mill

The idea of building a mechanical pulp mill is not a novel e for this enterprise. It was proposed as long as 26 years o when the Niskakoski Rapids on the River Oulujoki were ught with the intention of building a large mechanical lp mill working for export at Vaala, where Lake Oulujärvi charges into the Oulu River. However, the project proved possible of realization. The problem of adjusting the water el of Lake Oulujärvi proved too great. Instead, a sulphite ill was built on the seashore and this still constitutes the e of the activities of the enterprise. The idea of a me- nical pulp mill, however, has been kept in mind throughout the management; today it is close to its realization.

The power requirements of this mechanical pulp mill will be plied mainly by the hydroelectric power stations built on e rapids previously owned by the firm but now controlled Imatran Voima.

The extension project will be carried out in two phases, the of which is now nearing completion. The mill is planned an annual output of 30,000 tons, to be produced by means wo Roberts grinders. The first phase is the installation ne Roberts grinder.

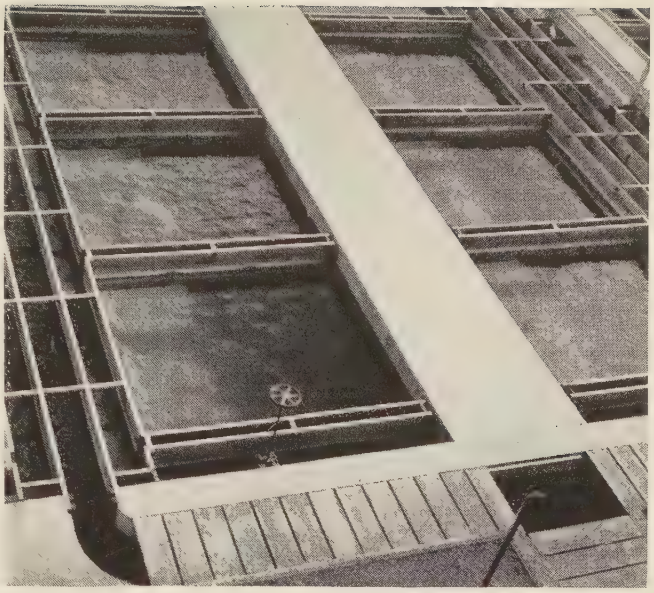
The new mill is situated north of the sulphite mill, approxi- ely 50 meters away, leaving space between the two mills possible driers.

The purchase, storage, and barking of timber for the mill is ked up with the existing organization for supplying the lphite mill. However, a slasher for cutting the standard gth of 2 meters down to 1 meter has been built level with e sorting table of the barking plant. The 1-meter bolts e carried to the mechanical pulp mill by a 200-meter long nveyor. The conveyor is supplied by Rauma-Repola y. The belt, over 412 meters long and 400 mm. wide, is pplied by Tammer Tehtaat. This conveyor ends some 4 eters above the water surface in a timber storage basin, of 0 cu. meters, alongside the grinders. Thus the wood can at freely to the apparatus.

The grinding apparatus consists of a Roberts ring-type inder supplied by Tampella, Finland, and fitted with an ndersen regulator for the operation of the feeding ring. All mperature adjustment and recording is by Leeds & North- p instruments. The grinding stone is a Norton stone, ameter 170 cm. and width 110 cm. running at 294 r.p.m. e machine is powered by a 3000-hp. electro-motor. The nnecting shaft between motor and grinder is fitted with o special flexible couplings easy to dismantle when the ne requires changing. This arrangement achieves a saving space as no supporting bearings are required.

For the transformation of the power current to the ground- od mill from 35 to 6 kv., a 10,000-kva. transformer has been ight from Marelli, Italy. All electric material apart from ne motors from England, and all installation work is by Strömberg Ab.

From the grinder the stock passes through a Tampella t screen and is collected in a pump pit below. From the the stock is forwarded by a 12,000 l./min. pump to the eening department on the second floor. Here a distribu- box built above the screens enables the screening to be usted as required by sluices. Double screening is oduced; the stock first passes through a coarser en and is subsequently fine-screened in two screens a finer mesh parallel coupled. All these screens are mpella Screens C. The refiner stock from all these ens is collected into a chamber by the above-men- ed distribution box, from which it is sent through a Dilts ner and pumped back into the system. The accepted k is led into three Tampella water separators from which allowed to fall direct into a chest of approximately 1000 meters. A Karhula Kamyr machine takes charge of the atering. Here the stock is pressed to approximately 55%



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and baled in the usual way. The mill laboratory, in addition to standard equipment, has a Bauer McNett fiber fractionation device to control the decomposition of fibers. The pumps for the mill are supplied principally by G. A. Serlachius Oy. The building has been planned and supervised by the well-known building engineer, Martti Niskala, and erected entirely by the company itself.

The entire production of the mill will be delivered to Peter Dixon & Son Ltd., England.

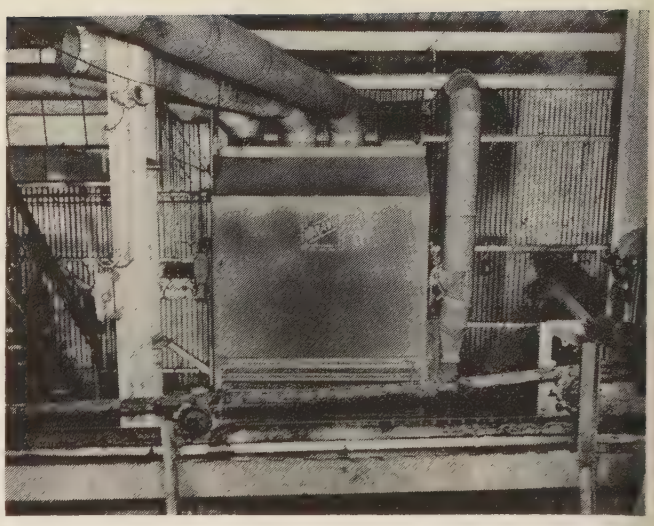
S. D. Warren

A heavy fog condition in an unheated log debarking building at its Cumberland Mills plant was causing the S. D. Warren Co., world-known manufacturer of fine printing papers, considerable trouble during the Winter months. S. D. Warren, founded in 1854, is one of the largest manufacturers of quality paper in the world. Its Cumberland Mills plant alone has 52 acres of floor space and uses 100,000 cords of wood yearly to produce more than 400 tons of paper a day.

In this initial papermaking operation, the incoming logs are sprayed with warm water to remove ice and attached dirt and wash away bark particles during the mechanical debarking process. The warm spray, upon contacting the frigid atmosphere, formed a dense fog that diffused throughout the entire building, and ventilating fans could not clear the air. Conditions were so bad that operators at conveyor controls could not see logs on the chain 4 ft. away.

The foggy atmosphere not only was an accident hazard, it made working conditions miserable. Other effects were that the moisture condensed on the machinery causing it to freeze up, and collected on and in electrical equipment to damage the insulation and cause short circuits and burn-outs.

Since fog is nothing more than an indication of the atmosphere's saturated condition—it is filled to capacity with moisture and the excess is condensing into a heavy mist—the most practical solution was to get heat into the building. This increasing of the atmosphere's temperature would enable it to evaporate more moisture and hold it invisible. But, under this condition, the humidity would always be near the saturation point with moisture condensing onto equipment at the slightest drop in temperature.



The Dravo Counterflow heater installation at the S. D. Warren Mill

To effect a complete cure of the moisture problem, Warren Co. engineers installed a Dravo Counterflow, 1,250,000 B.t.u. per hour, oil-fired space heater in each end of the

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ilding. Fresh air from outside is forced through the two ters by their individual blowers and distributed to critical eas in the building through overhead ducts. This method only heats the building, it forces the moisture-laden excess out open windows at the top. Damper arrangements vide maximum flexibility to recirculate inside air when missible as well as temper incoming fresh air.

The building is of corrugated metal construction with a 2- layer of cellular glass insulation applied to the metal roof. th a floor area of 5500 sq. ft. and average ceiling height of ft. the building's estimated heat loss is 2,100,000 B.t.u. hour. The heat source, designed on the basis of 55°F. de and −10°F. outside, has been entirely adequate to ntain an inside temperature of 70°F. consistently. Thus absence of fog and the comfortable temperature not only ice the accident hazard and improve the working condi- s, the plant now operates on full schedule without time for abnormal breakdowns.

ALIFAX PAPER

Expansion of the Halifax Paper Co.'s Roanoke Rapids nt in North Carolina has been completed, according to the neer-constructor, The Rust Engineering Co. of Pitts- gh and Birmingham, Ala. Cost of the project was $5,- 000.

The new addition augments the plant's existing facilities the production of unbleached kraft paper. The project ded construction of a two-story building to house a new 6-in. paper machine and its necessary stock preparation uipment, as well as additional finishing and shipping facili- s, a high density pulp storage tower, and a 6,000,000-gal.- r-day water treatment plant.

The mill's new 246-in. fourdrinier paper machine can oper- e up to speeds of 2500 f.p.m. Its forming wire is 130 ft. ng. The machine comprises 33 paper driers, two felt driers (60 in. in diameter; able to withstand 125 p.s.i. pressure), latest type press section, pressure type headbox, a six-roll calendar stack, breaker stack, Beloit mechanical sectional drive, mechanical reel puller, and a Jamar Olmen ventilating system.

Necessary alterations were also made to the existing paper mill in order to integrate its production with the new addition. The new building was designed to permit installation of a second large paper machine at a later time in the most economical way without interrupting or slowing down mill operations.

In the past this plant at Roanoke Rapids has had a number of "firsts" notable to the pulp and paper industry, since it was the first sodium sulphate mill in the United States, and the first mill to use southern pine by the new sodium sulphate process. It was also the first mill to use tumbling digesters, and the first to provide diffusers for washing the southern pine pulp. Further, its 104-in. paper machine was the first to make kraft paper from the southern pine pulp.

UNION BAG

Two miles northwest of Soperton, Ga., on the town's main highway artery, lies a 12-acre tract of land that, over the next 10 years, is going to teach a lot of Treutlen County boys the art of capitalizing on this state's biggest cash crop—pine trees.

It's all part of a program sponsored by Union Bag & Paper Corp. in cooperation with the Georgia Div. of Vocational Agriculture, to instruct and encourage pupils in Georgia high schools in the better methods of handling woodlands on the farms.

Soperton High School's vocational agriculture class has become one of the first of 40 such classes to establish what is to be known as the School Forest.

It's a regular "test tube" woodlands where the 33 FFA youngsters in this year's vocational ag group, and the classes for the next 9 years, will augment the traditional blackboard

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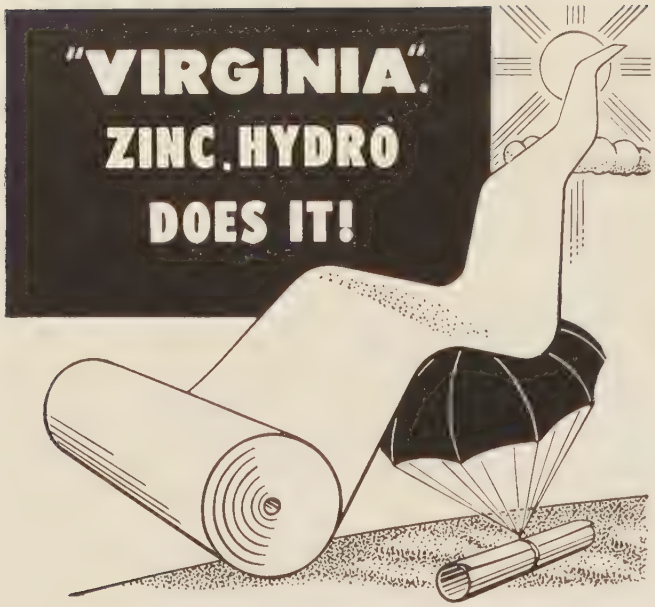

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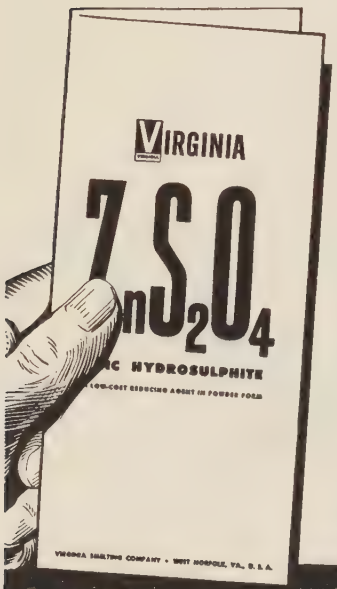
We hope you'll check the claims made here for the effectiveness and economy of "Virginia" Zinc Hydrosulphite. When substantiated, they should go a long way toward "selling" you on using this proven chemical in your operation. Write today for a free test sample and our recommendations for its use. No obligation.



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and textbook schooling with practical, in-the-field experience on the 12-acre tract.

Under the direction of the school's vocational ag teacher, Huber H. Glisson, the class has been turned loose on pretty much of a sink or swim basis. Any expenses involved, for axes, plowing, planting irons, etc., are to be borne by the class, and when any timber is sold, for saw timber, poles, or pulpwood, the class reaps the profits.

The 12 acres of land which now compose the Soperton School Forest were contributed by J. C. Stephens, Soperton businessman. The land is under a 10-year lease to the local FFA chapter, and Mr. Stephens is paying the taxes during that period.

In return, at the end of 10 years, foresters assure him he will have one of the best managed timber tracts in the county.

To stimulate interest in the school forest program, which is being set up in 40 high schools throughout the southern part of Georgia, Union Bag is offering annually a first prize of $100 and a second prize of $50 to classes judged to have done the most outstanding work with their tracts.

Additional prizes of $100 and $50 will be awarded to the teacher of the winning chapters, and $100 will also be presented to the outstanding pupil with the best forestry project, to be used to finance a trip to the national FFA meeting at Kansas City.

Experimental plots will be set up on the School Forest so that 10-year records may be kept on mortality, height, diameter measurements, and thinning results.

Like all woodlands owners in the state, the school forestry projects will have at their disposal the services of Union Bag's conservation foresters who will advise on forestry problems.

The ultimate goal of the projects, Union Bag foresters explain, is to show the boys how to get the best possible returns from their farm woodlands.

They will be taught the best marketing procedures, and when their timber is best suited for poles, lumber, or pulpwood, they will be advised of it.

Mink from Yeast

Fashionable fur coats will be nourished on a pulp and paper industry by-product instead of horsemeat if research now under way at Michigan State College turns out favorably. Professors at the big agricultural college are testing the effects of feeding ranch-grown mink a diet rich in torula yeast made from spent sulphite liquor to supply vitamins and other growth factors previously supplied by a meat and fish ration.

One reason why mink coats are expensive is that it costs so much to feed mink the meat they have always been given. As the horse population rapidly declines, the price of horsemeat is rising into the higher brackets along with lamb chops and porterhouse. Mink ranchers say they have to find an adequate substitute which will grow mink at less cost or many a Broadway showgirl might have to get along with cat fur.

Animal nutrition experts at Michigan State, casting about to find ingredients for a dry ration that mink could thrive on, tried out torula yeast obtained from the Sulphite Pulp Manufacturers' Research League, the research organization cooperatively supported by 14 Wisconsin-Michigan pulp mills to work on problems of reducing sulphite stream pollution. Preliminary results of these feedings indicate that a dry diet containing high levels of torula yeast might produce just as thick fur and as healthy litters as a Percheron roundsteak. Yeast for the diet is made from spent sulphite liquor by Rhinelander Paper Co. in its by-products division.

With this encouragement, the League has just now concluded a cooperative research agreement with the college to make a thorough test of torula yeast for mink feeding. The college will start with 30 adult mink. In groups of 10 they will be fed two control rations and an experimental diet of "X Mink 9" containing torula yeast during the periods of gestation, whelping, and lactation. The young mink, called kits, born in May and fed torula yeast feed until early Winter

en most of the males will be pelted out to determine e quality and value of their skins. The remainder of the nk will be fed the torula yeast diet through another year's le to yield reproduction data. Also, three commercial nk ranchers will feed X Mink 9 to part of their adults to get practical tryout of the nutritive value of this ration.

. Regis

St. Regis Paper Co. has announced the award of its Fellowip in Forestry to Rexford A. Resler, a senior at Oregon te College who plans to continue in graduate work at that ool next Fall.

This fellowship was offered by St. Regis last Fall to first ree holders planning to take graduate work at any accredschool of forestry in the United States, at the same time it offered five undergraduate scholarships in forestry, e tive in the academic year 1953–54.

The committee responsible for making the graduate award composed of R. E. McArdle, Chief of the Forest Service, S. Department of Agriculture; V. L. Harper, Assistant f, Forest Service; and A. B. Recknagel, Technical Direcof Forestry for the St. Regis Paper Co.

In making the award the committee gave particular attento the experience of the candidates in addition to their lastic record.

Three of the undergraduate scholarships, for which applits may file up to Sept. 1, 1953, are available in the South, d one each in the Northwest and Northeast.

The scholarships in the South are being provided, one each, Alabama Polytechnic Institute, University of Florida, and niversity of Georgia. Each amounts to $800 a year for a riod of 2 years, and will be awarded to an outstanding Junior udent in forestry at the above-noted schools.

The scholarship available for undergraduates in the Northst will be for a period of 2 years, at $800 a year, for one outanding Junior student in forestry at either the Univery of Washington or Oregon State College.

In the Northwest, a single scholarship is being offered to an tstanding Junior Forestry student chosen from one of the llowing schools: University of Maine, University of New mpshire, University of Massachusetts, or New York ate College of Forestry. This scholarship will also provide 00 for each of 2 years.

The company will offer to each of the undergraduate olarship winners employment during the intervening mmer on some forestry project. Their continuance as ipients during the Senior year will depend upon record in field as well as in school.

Fellowship in Forestry, valued at $1000, covers only 1 year d the award winner is expected to direct his studies along es of value to the pulp and paper industry.

TT

Scott Paper Co., Chester, Pa., has announced the establment of an experimental scholarship at Swarthmore llege on a modest basis "to determine if the company and college can benefit mutually through corporate support of vate institutions of higher learning."

The grant, made known by Thomas B. McCabe, Scott sident and a graduate of Swarthmore, will be called the tt Award at Swarthmore. It will be given each year for next 5 years to a sophomore student who plans to enter iness after graduation. The award will provide the reent with $1000 for each of his last 2 years in college.

Along the the scholarship, which honors Arthur Hoyt tt, one-time Scott president and a 1894 graduate of rthmore, Scott Paper Co. will contribute $1000 each year Swarthmore College.

It was made clear that if this limited experiment produces results which Scott and Swarthmore anticipate, Scott extend the scholarship program to certain other colleges

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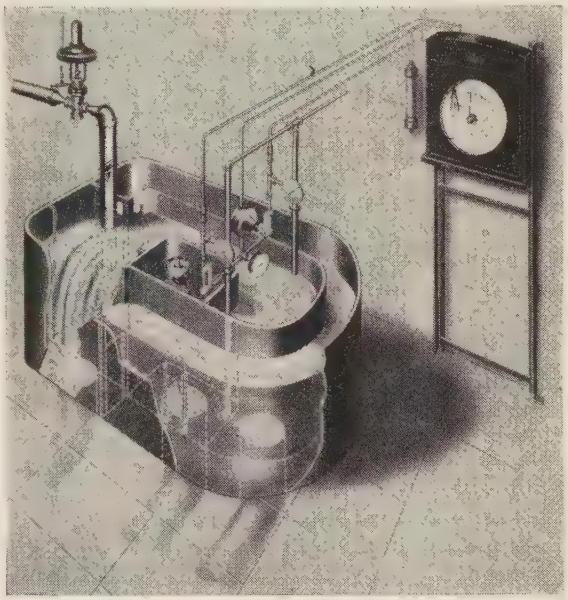

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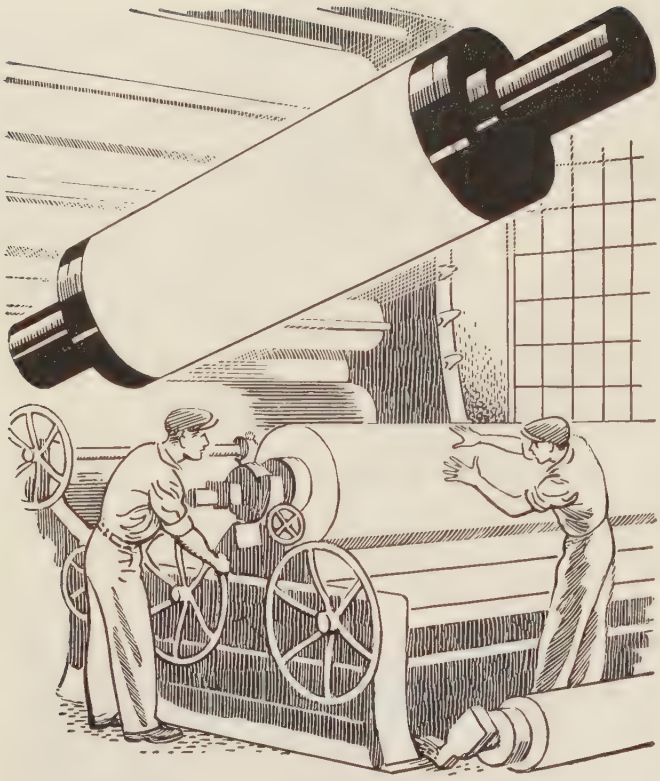

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and universities whose graduates have had successful records with Scott.

In announcing the scholarship, Mr. McCabe said that "Scott Paper Co. will offer each recipient, while in college, Summer employment of a nature calculated to further the student's educational program, but that acceptance of Summer employment was voluntary and not mandatory on the part of the recipient." He said further that "the company is naturally hopeful that upon graduation sufficient recipients of the award will join its organization on a permanent basis to make the experiment productive," but said that he recognizes "there can be no assurance of such results, as neither the company nor any recipient is under obligation with respect to employment after graduation." He emphasized that the program is entirely voluntary.

In commenting further, Mr. McCabe said that in initiating this modest experiment at Swarthmore the company wished to determine if a profitable return could be obtained by the company in rendering financial assistance to the college. One of the company's most expensive operations, he said, "is the recruitment and training of high caliber personnel. If more high caliber recruits could be obtained and the number of unsuccessful candidates could be reduced, the savings would obviously be substantial.

"The concept underlying this award," Mr. McCabe said, is that students who expect to enter business may be stimulated by these scholarships to strive for a proper balance of desirable personal qualities and not limit themselves to any one particular area of interest whether it be scholarship, athletics, dramatics, social life, or any other specific extracurricular activity. A proper balance among all these qualities is often indicative of the potential business leader." Therefore, to be eligible for the award the student must, in addition to having signified his intention to enter business, have demonstrated in both classroom and extracurricular activities those qualities associated with the well-known "Rhodes scholars"—scholastic ability, character, personality, leadership, and physical vigor.

The Scott scholarship program, if successful, will aid private educational institutions in meeting their financial budgets particularly when added to the scholarship and financial aid programs of other industrial concerns.

Mr. McCabe said that "Scott Paper Co. has become increasingly aware of the difficulties faced by private colleges and universities in meeting the rising costs incident to a sound program of advanced education. Realizing full well," he said, "that industry must continue in the future, as it has in the past, to look to them for a large share of its key operating personnel and potential management executives, the Scott Paper Co. is fully cognizant of the responsibility of encouraging and assisting them through a program of corporate giving as embodied in this scholarship program. Such responsibility on the part of industry must be recognized and accepted," he said, "if our privately supported educational institutions are to survive. These institutions are certainly an integral part of the American way of life and they constitute one of the strongest factors in contributing personnel, its very life blood, to the American competitive enterprise system."

The first recipient of the Scott award at Swarthmore is Henry J. Bode, Jr., son of Mr. and Mrs. Henry J. Bode, 125 Hoyt Ave., Rumford, R. I. Young Bode is president of the sophomore class, co-captain-elect of the varsity wrestling team, and is a member of the varsity football and track teams. He was vice-president of his class during his freshman year. Bode is a member of Delta Upsilon national fraternity and is holder of a national George F. Baker scholarship. He plans to major in mechanical engineering.

Bode was selected by a committee which included members of both the faculty and student bodies. It was made up of two vice-presidents of the college, the dean of men, dean of women, the president of the student council, the women's

ient government association, the men's executive com-tee, and representatives of the junior and senior classes.

ON

The Upson Co., Lockport, N. Y., has developed a wall-rd that will not warp. The problem was studied by ter Ericks, a TAPPI member, who worked out a process of ting the fibers principally with glycol dicarboxylic and noesters, partial esters of polyhydric alcohols and poly-oxylic acids, and polyhydric alcohols and polycarboxylic ds themselves.

Monoesters of the first group containing 8 to 14 straight n carbon atoms, produced by the reaction of glycols with a boxylic acid anhydrides, have proved most effective so

Ericks found in the course of his research that organic pounds with a molecular weight under 6000, and with o or more hydroxyl units in the molecule had high affinity cellulose. After narrowing the field to the present three s he believes that he now has chemical stabilizers that each the interstitial gaps in cellulose before water reaches m. These chemicals may be applied by spraying, im-sion, or mixing in the beater.

The following is the statement by J. H. Hinman in the re-t financial report of the International Paper Co.

I think this is an appropriate time to say a few words on the ject of research. It is rather widely recognized, I believe, t research is one of the most important competitive tools in dustry today. The creator of a new and better product s an advantage. If an organization does not create new and tter products its competitors very likely will—and that kind competition is almost impossible to beat.

I have discussed this with you before but let me review the ts—because I think they are important and impressive.

Our company, in common with other important manu-turers of pulp and paper, developed standard facilities for cking manufacturing processes may years ago. The first solving pulp research laboratory ever established by the per industry in North America was established in Hawkes-ry, Ont., in 1923. This laboratory, now Industrial Cellu-e Research Ltd., one of our affiliates, is undoubtedly the most research organization of its kind on this continent l perhaps in the world. It has not only made outstanding tributions in the field of pulping techniques and processes has also made important contributions to modern rayon nufacturing techniques and has developed processes which ved to broaden the use of dissolving pulps in industry.

The forest resources of Canada and the United States have n greatly expanded by Hawkesbury pulp research, which helped make it possible to use a greater variety of tree cies in pulp production. This has not only increased the ilable supplies of wood but it has made possible a more ient and economical management and harvesting of ilable forest lands.

Very soon after the establishment of the Hawkesbury re-rch laboratory, the central testing facilities of our Northern ss, located at Glens Falls, N. Y., were expanded into our sent Glens Falls Research Laboratory. Glens Falls has tributed many important developments, including Inter-onal's process for bleaching groundwood pulp, the im-vement of formulas and techniques for coating paper, and standing developments in the manufacture of book stock. en the Ticonderoga mill was converted from soda pulp kraft and to the use of hardwoods, the successful results ined were largely due to the cooperation of Glens Falls the mill organization. Much has been accomplished in eloping by-products from waste sulphite liquor, and tional research along these lines is being carried on. Laboratory continues active development of new grades processes with particular attention to the needs of the

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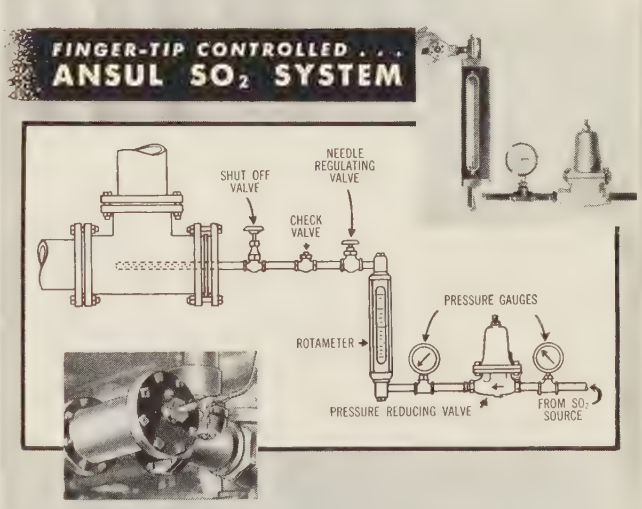

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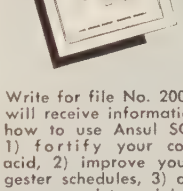

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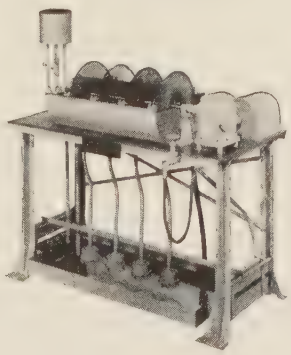
Write for file No. 200. You will receive information on how to use Ansul SO_2 to 1) fortify your cooking acid, 2) improve your digester schedules, 3) obtain more complete pulping, 4) get better screening of pulp and, also, 5) for green wood cooks.

ANSUL Chemical Company

INDUSTRIAL CHEMICALS DIVISION • MARINETTE, WISCONSIN

MANUFACTURERS OF INDUSTRIAL CHEMICALS. FINE CHEMICALS. REFRIGERANTS. REFRIGERATION PRODUCTS AND DRY CHEMICAL FIRE EXTINGUISHING EQUIPMENT.

CLARK MODEL 46
THE STRAIGHT LINE
PULP CLASSIFIER



Control beating and refining processes on groundwood or chemical pulps. Excellent for coarse and fine pulps. Screens from 8 to 250 mesh available. Eight complete tests in one hour. Results reproducible within 1%. No recirculation or eddy currents. Open construction offers visual proof of progress of classification. Easily cleaned. Minimum Maintenance.

THWING-ALBERT
INSTRUMENT COMPANY
5383 Pulaski Avenue
Philadelphia 44, USA
105

EST. 1884 — CORPORATE 50th ANNIVERSARY — INC. 1903

We accept
FULL Responsibility for
Designing, Installing
and Maintaining your
corrosion-resistant
Tile Tanks and Linings

Our own engineers design the job. Our own skilled crews install it. Our own service men maintain it. One contract covers the whole thing, with responsibility resting squarely on us.

We accept the responsibility; long experience and ample resources permit us to do so.

One typical result: 80% of all chemical pulp made in North America is processed at some stage in equipment built or lined by Stebbins.

SEMCO
STEBBINS
Engineering and Manufacturing Company, Watertown, N. Y.
STEBBINS ENGINEERING CORP. — TEXTILE TOWER, SEATTLE, WASH.
CANADIAN STEBBINS ENGR. & MFG. CO., LTD. — CASTLE BLDG., MONTREAL, CANADA

Northern mills, although close liaison is maintained with developments being carried on elsewhere in the companies.

Our newest research laboratory was opened last October at Mobile—headquarters of our Southern Kraft Div. While it was built around our existing research organization and activities, our aim was not to centralize the work but to broaden the scope of the division's research activities.

The new laboratory at Mobile contains the most modern facilities for all types of pulp research with five principal divisions: pulp research and development, paper research and development, physical testing, chemical analysis, and dissolving pulp research and development.

Behind this establishment is the long record of our manufacturing and research people in the South. Among other things they were first in the mass production of kraft linerboard made from southern pine on fourdrinier machines. They were first to develop a successful bleaching process for mass production of both kraft paper and board in the South and they originated our process for using Southern hardwoods to produce Chemfibre, the company's exceptional corrugating medium.

As a concrete example of what a progressive, effective research program can mean to our company, let me review our experience in the field of dissolving pulp.

The first mill in North America designed to make rayon dissolving pulp from wood by the sulphite process, now our Kipawa mill, at Temiskaming, Que., started operation in 1920. Until then rayon manufacture in North America had been from cotton linters, although some small shipments of dissolving wood pulp had been received from overseas.

In 1938, our Southern Kraft Div. started looking for a way to make dissolving pulp by the kraft process. In the early 40's, this project was expanded in cooperation with the pulp research scientists at the Hawkesbury laboratory and an intensive development program was begun. About 1944, the process had reached the point where trial runs were begun, using our Louisiana mill as a full-scale pilot plant. The experimental dissolving pulps produced there were processed and spun into rayon at the Hawkesbury laboratory's rayon pilot plant. Riordon Sales Corp. also arranged for trial shipments to their customers.

As the results obtained in the trial runs at Louisiana improved, we decided to try to adapt this process to use the hardwoods that abound in the Southern forests and by mid-1948, kraft dissolving pulp made from hardwoods had been developed to the stage where plans were drawn for production at a new mill.

The combined efforts of these two research organizations led directly to the construction of our $43,000,000 mill at Natchez, Miss. The Natchez mill is unique. Designed to use hardwoods, it can make either dissolving pulp or bleached paper pulp of the highest quality. The fact that hardwoods can be used is particularly important, enabling us to broaden the base of our forestry operations in that area.

Subsequently, the mill at Hawkesbury was able to adapt its process to use the Canadian hardwoods that abound within a 50-mile radius—with the result that today the mill at Hawkesbury is completely supported by local forests and no longer needs to bring in wood from long distances.

One of the research lines that is receiving increasing attention from the pulp and paper industry is the utilization of the complex wood chemicals remaining after the wood cellulose fibers have been separated in the cooking process.

Originally, these chemicals were considered as waste. Later, when the kraft process was developed, it became possible to burn the noncellulose wood constituents of the waste liquors and retrieve a large percentage of the cooking chemicals for re-use.

In 1930 International Paper Co. and American Cyanamid Co. formed a jointly owned subsidiary, Arizona Chemical Co. Using the research facilities and the technical manufacturing and sales experience of the parent companies

rizona Chemical Co. has developed practical methods for tracting a number of commercially useful by-products om kraft cooking liquors.

Today, Arizona Chemical Co. collects part of this residue n all of our southern kraft mills and converts it into crude l oil in plants located at three of our kraft board mills. addition it has two refining plants adjacent to our Panama it / mill—one of these, by a process of distillation, separates ude tall oil into rosin and fatty acids, which are widely used the paper industry; for synthetic resins and plastics; for e production of paints and other surface-coating materials; for ore flotation, soap, rubber compounds, and disin- lants. The other plant refines the crude sulphate tur- ntine recovered during the cooking process at our kraft l's and then processes it to alpha pinene, beta pinene, and ious other pinenes, which have a large market for use in ace coatings, synthetic camphor, in the paint industry, as ricating oil additives, and for various other purposes.

In addition to these operations, Arizona Chemical Co. ow conducting advanced laboratory work which we hope ll enable us to proceed further with the purification of these plex chemicals—particularly the rosin and fatty acids—to many valuable products. Even after the rosin and ty acids have been extracted, there remain complicated nic chemicals for which valuable uses may well be dis- red.

I have made frequent references to our forest research activi- s. As you know, we maintain a highly significant experi- tal forest at Phillips Brook, N. H., and another at ausapscal, Que. In addition, we do a lot of experimental ork of a more informal character elsewhere on our forest nds. But since we are discussing research, I would like to ll your attention to an unusual and, I think, important periment being conducted at Harrington, Que. There, nadian International Paper Co. has established a Forest arm to experiment with forest development methods and to monstrate to farmers throughout that area the methods and tentialities of tree farming. On land held by that com- ny, and on farmlands within 50 miles of the Hawkesbury ll, it now appears quite certain that enough wood can be own in perpetuity to meet all the needs of the Hawkesbury ll. Canadian International Paper officials believe that a nificant portion of the wood needs of Canada's pulp and per industry can be supplied by tree farmers and other ivate producers.

CROWN ZELLERBACH

Edward P. Stamm, Logging Manager of Crown Zellerbach rp. since 1935, recently was advanced to Vice-President. s office will be located at Portland, Ore. He joined CZ as a gging Engineer in 1927.

Precipitator installations designed to prevent cinders from aping its Lebanon paper mill stack have been approved by own Zellerbach Corp., Resident Manager B. C. Smith an- nced recently. The project will cost about $80,000. uipment will be ordered as soon as final engineering plans ve been completed.

A new stack will be built and the precipitator unit installed ween the mill boilers and the stack. Cinders will be col- ed by mechanical means and blown back into the boilers be burned. About 150 more horsepower will be required to the new draft fans which are part of the installation.

ROBERT GAIR

James G. Van Horne, Jr., has been appointed Sales Man- r, boxboard, American Coating Mills Div. of Robert Gair

Paul C. Meelfelt has been appointed Sales Promotion Man- r of the Container Operations Div. of Gair. Mr. Meelfelt formerly Assistant Vice-President of Hinde & Dauch per Co. with whom he had been associated for 35 years.

COMPLETE ENGINEERING AND CONSTRUCTION SERVICES FOR THE PULP AND PAPER INDUSTRY

If you have a problem involving any of the following, you can get immediate and experienced help from EBASCO engineers and consultants:

- Design and Construction of Pulp and Paper Mills
- Steam and Hydro-Electric Power Plants
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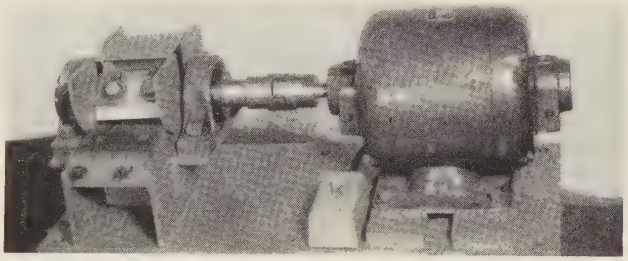


TAYLOR-STILES NEW TRIM CUTTERS

—automatically cut up edge trimmings into short pieces for reprocessing, as the paper comes off the machine. This is work that usually requires expensive manual labor.

Two of these small trim cutters, one on each side of the paper machine, may be mounted on a single shaft and operated by one motor or may have a direct connected motor for each trim cutter.

Write for full description of this efficient device.
(Folder App 208)

TAYLOR-STILES and Company
CUTTING MACHINES & KNIVES

48 Bridge Street Riegelsville, New Jersey

IF YOUR PROBLEM IS IN

TEFLON

YOU GET BEST RESULTS FROM

CHEMICAL & POWER PRODUCTS

One of the prime examples of the advances Chem.-Power's engineers have made are the flexible "Seal Cages."

The Secret:

Careful attention to detail whether your order be for sheets, rods, tubes, gasket or for a specially machined part. No order is too small, none too large. If you have a problem which you feel that Teflon can solve, pass it along to our Engineering Department for solution.

CHEMICAL & POWER PRODUCTS, Inc.

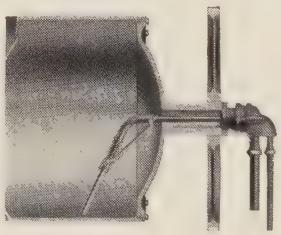
11 Broadway, New York 4, N. Y.

Reaction of ¾" Auto-Flex in 48" dia. dryer. Very low leverage.

Reaction of ¾" ordinary bent pipe. Syphon in 48" dia. dryer. High leverage.

THIS SYPHON HOLDS ITS POSITION AND SERVES INDEFINITELY

Midwest Auto-Flex syphons have been on the market for years and many thousands are in service for two very excellent reasons — they hold their position — they wear indefinitely.



1. The spring and brace holds the end of the pipe at the proper distance from the bottom of the dryer. It cannot take any other position—hence, proper water and air removal.

2. The cantilever leverage exerted is lower than with bent pipe syphons, only 170# vs 354#. It clears instead of dragging on the journal and rapidly wearing out.

Order a get acquainted dozen. Performance guaranteed.

MIDWEST-FULTON MACHINE COMPANY
DAYTON, OHIO

ST. CROIX

Robert J. Hackett has been employed as sulphite Superintendent of the St. Croix Paper Co., Woodland, Me.

GLATFELTER

The P. H. Glatfelter Co., Spring Grove, Pa., is presently engaged in an expansion and improvement program of pulpmaking facilities. The program includes an increase in present digester output, plus necessary auxiliary equipment for handling the increased production; the installation of modern liquor making and recovery equipment and the modernization of the bleachery to conform with the broke quality requirements of the company's diversified line of papers.

DOW CORNING

The Dow Corning Corp. celebrated its tenth anniversary during the week of May 3 with an open house at Midland, Mich. Dow Corning started out 10 years ago with a legacy of 9 years of basic research in the field of silicone chemistry. The basic research was done by a group of chemists and physicists headed by J. Franklin Hyde under the general supervision of E. C. Sullivan of the Corning Glass Works.

Gross sales increased from $15,000 during its first full month of operation to $1,500,000 a month 10 years later. The company is now investing $16,000,000 in a new expansion program that will give it a fourfold increase in capacity.

Silicon with its four valences has properties similar to carbon in its ability to produce a wide variety of compounds. In most silicone products the silicon and oxygen (quartz, mica, or sand) skeleton is fleshed out with methyl or phenyl groups attached to the other valences of the silicon atoms. That results in a family of new and radically different engineering materials including fluids and oils, compounds and greases, resins and varnishes, and a rubbery solid called "Silastic."

Silicon metal is the starting material. Dow Corning produces this in a 6000-kva. electric furnace in which quartz rock, charcoal, and coke are reacted in an electric arc at 3100°C. to produce about 250 tons of silicon per month.

"Silica soot" prepared by the Grignard reaction is condensed from silica smoke produced from burning silicon tetrachloride in combustible gases and is characterized by incredibly fine particle size and high surface energy. There are in the order of 31 million trillion particles in an ounce of silica soot. It is added to silicone rubber or Silastic in the same way and for the same purpose that carbon black is added to rubber. It is white in color.

The electrical industry is expected to become the principal user of silicones since the latter, used as a wire insulator, has

Sight Saver machine at Dow Corning

about twice the strength of other insulation from very low to very high temperatures.

Of interest to the paper industry is the silicone-coated tissue used for wiping eyeglasses and silicones used as defoaming agents. Silicone-treated fabrics appear to have no equal as water repellents.

DU PONT

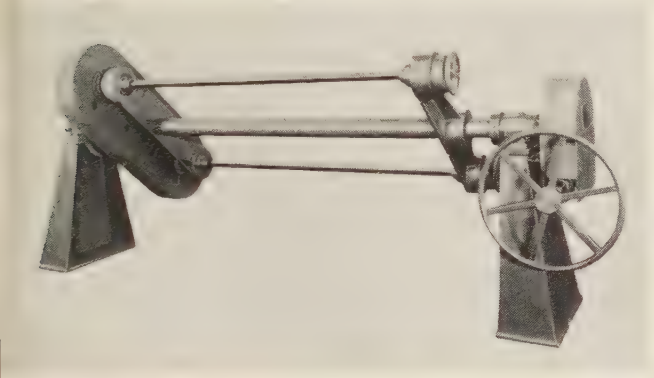
E. I. du Pont de Nemours & Co., Wilmington, Del., has issued a new 32-page illustrated booklet entitled "The Builders" celebrating Du Pont's 50th anniversary. Of interest is the statement that Du Pont's Orlon acrylic fiber plant constructed in Camden, S. C., requires one million blueprints and over 5000 purchase orders.

WESTINGHOUSE

Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa., has issued booklet B-5622 on "A.-C. Welding Equipment." Three basic alternating-current welding machines are appraised in the 17-page booklet.

DILTS

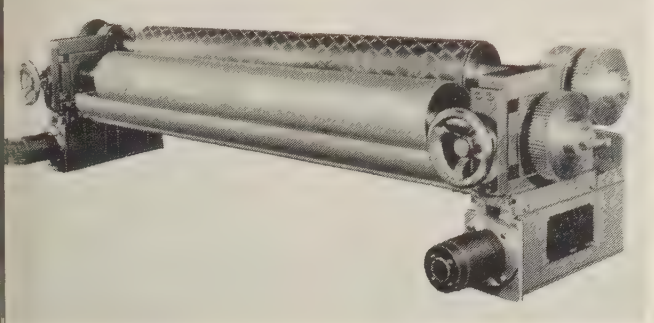
Dilts Machine Works, Fulton, N. Y., has issued two interesting bulletins 12-DM on the Contracoater and 13-DM on converting machines. The Contracoater is a four-roll reverse roll coater for applying resins, lacquers, latices, organisols, plastisols, emulsions, dispersions, and rubber cements to webs of paper, felt, foil, and fiber.



Dilts continuous two-arm winder

Dilts has announced a new low-cost two-arm winder for continuous winding of relatively small diameter rolls at moderately low operating speeds.

It is particularly applicable to coating operations where stops for roll changes result in off-quality of the coated web in the over. By reducing the down time for roll changes, increased efficiency and production also result.



Dilts flexographic trade-mark printing press

DYESTUFFS
and
AUXILIARIES
for the Paper Industry

★ BEATER ★ CALENDER

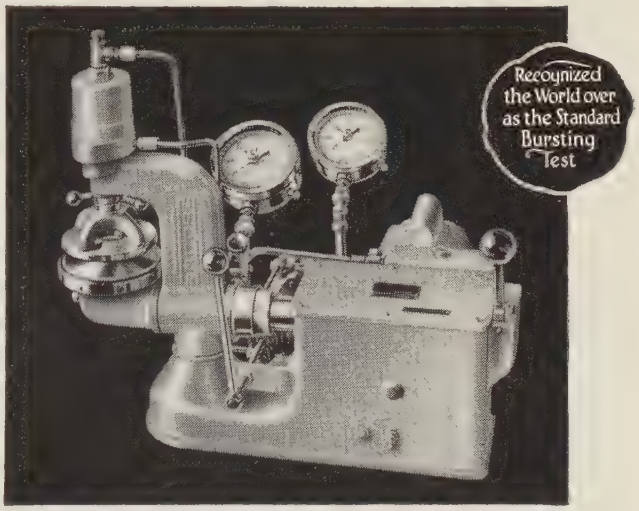
★ COATING MACHINE

★ ANILINE PRINTING

Geigy
DYESTUFF MAKERS SINCE 1859

GEIGY COMPANY, INC.
89-91 BARCLAY STREET, NEW YORK 8, NEW YORK
BRANCH OFFICES: BOSTON • CHARLOTTE, N. C. • CHICAGO • LOS ANGELES
PHILADELPHIA • PORTLAND, ORE. • PROVIDENCE • TORONTO
IN GREAT BRITAIN: The Geigy Co., Ltd., Manchester

Motor Driven Model A Tester
With Hydraulic Clamping Device

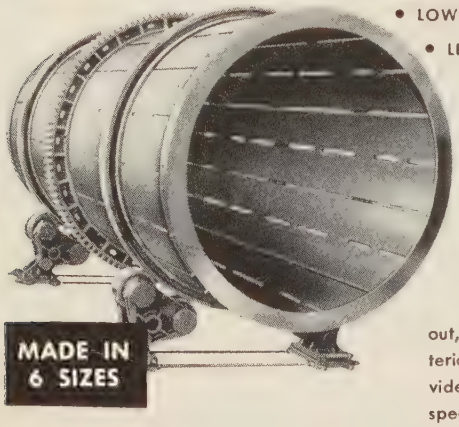


Especially designed for testing corrugated container board. Larger clamping area and reproducible clamping at any desired pressure eliminates crushing and slippage of the sample.

Write today for prices on these new testers, also the cost of converting your present Model A machines.

B. F. PERKINS & SON, INC.
Holyoke, Massachusetts

MURCO PLATE-SHELL TYPE
BARKING DRUM



- LOWER MAINTENANCE
- LESS BROOMING
- CLEANER WOOD
- LESS POWER

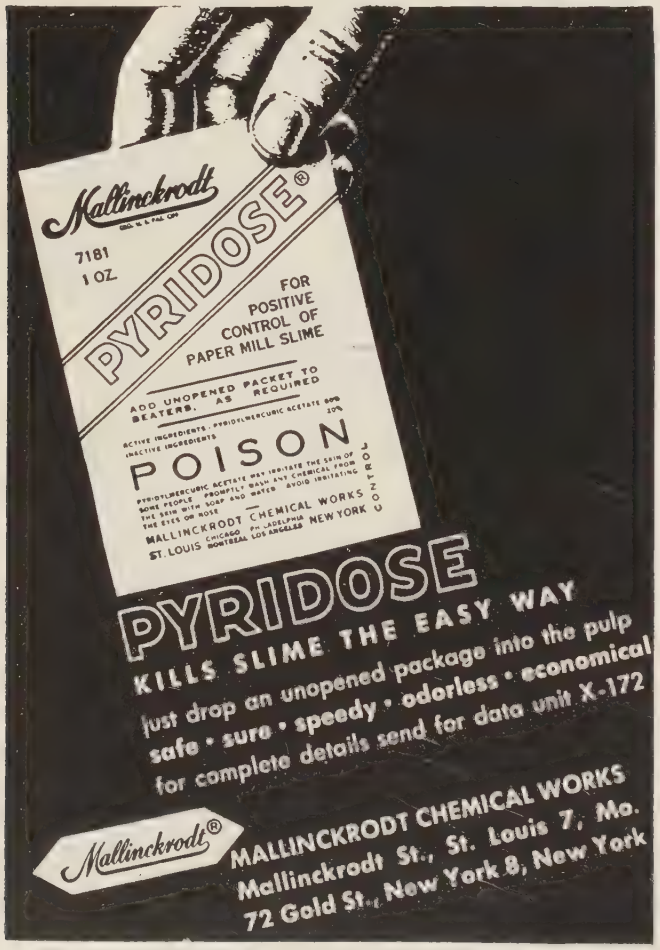
MADE IN 6 SIZES

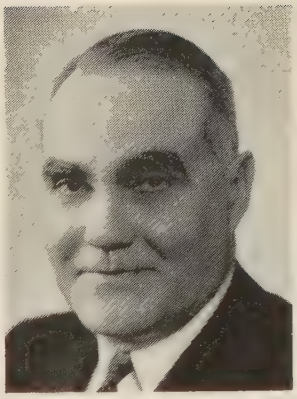
Heavy duty, rugged design, high-grade workmanship throughout, MURCO smooth interior barking drum, provided with sprays, when specified delivers cleaner wood, because the smooth interior minimizes bruising and brooming.

True barking action comes from the friction of log against log in a rubbing action. Barking is not due to a rough interior that only brooms the ends of the pieces . . . Completely designed as heavy duty equipment. You can depend upon MURCO Plate-Shell type barking drum to operate efficiently with a low maintenance cost, plus the fact that it delivers cleaner wood which means cleaner paper.

WRITE FOR DETAILS

D. J. MURRAY MANUFACTURING CO.
WAUSAU *Manufacturers Since 1883* WISCONSIN


Mallinckrodt
7181
1 OZ.
PYRIDOSE®
FOR POSITIVE CONTROL OF PAPER MILL SLIME
ADD UNOPENED PACKET TO BEATERS AS REQUIRED
POISON
MALLINCKRODT CHEMICAL WORKS
ST. LOUIS NEW YORK
PYRIDOSE
KILLS SLIME THE EASY WAY
just drop an unopened package into the pulp
safe • sure • speedy • odorless • economical
for complete details send for data unit X-172
Mallinckrodt®
MALLINCKRODT CHEMICAL WORKS
Mallinckrodt St., St. Louis 7, Mo.
72 Gold St., New York 8, New York



Albert E. Forster, Hercules Powder Co.

O. L. Marlett, Great Lakes Carbon Corp.

Adaptable to speed ranges from 100 to 500 f.p.m., with roll changes at reduced speeds, the Dilts Model 15 Winder will effectively handle roll weights up to 1000 lb. The maximum roll diameter handled is 30 in. Roll widths range between 30 to 60 in.

The Dilts flexographic single-color trade-mark printing press provides a quick and inexpensive method of applying manufacturers' trade-marks or trade names in over-all patterns to web materials. It is particularly adaptable to printing continuous web materials—such as paper or board—the press can also be used for over-all coloring or tinting. Compactly designed and constructed for ease of installation in a minimum of space, the Dilts Flexographic Printing Press is applicable to in-line operation with other existing converting machinery such as saturators, bag tubers, and laminators.

Hercules

Albert E. Forster was recently elected President of the Hercules Powder Co., Wilmington, Del. He succeeds Charles A. Higgins.

Hercules has issued a new bulletin on "Lacquer Emulsions Formulation and Use." The two main sections of the booklet are devoted to discussions of emulsion composition and preparation.

Dicalite

De Otis L. Marlett has been elected Vice-President of the Great Lakes Carbon Co., 612 S. Flower St., Los Angeles 17, Calif., and General Manager of the Dicalite and Perlite Divs. Mr. Marlett joined the company in 1952, coming from the Bonneville Power Administration where he served for 12 years.

Brown Instruments

Minneapolis-Honeywell Regulator Co., Wayne & Windram Aves., Station 64, Philadelphia 44, Pa., has issued a new catalog 8305 on "Industrial Controls—Electric, Electronic and Pneumatic."

Morningstar-Nicol

Herbert F. Gardner, formerly of the Pabst Brewing Co., has joined the Paper Mill Dept. of Morningstar-Nicol, Inc., 630 W. 51st St., New York 19, N. Y. Mr. Gardner was formerly Chief Chemist of the Chicago plant of Stein, Hall & Co.

Morningstar-Nicol, Inc. has issued a new bulletin G-101 on "Gum Arabic."

Safety

The National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill., has issued its Service Guide 2.1 on "Occupational Safety Services."

M. H. Isenberg, Combustion Engineering, Inc.

J. V. Santry, Combustion Engineering, Inc.

COMBUSTION ENGINEERING, INC.

In addition to shortening its name Combustion Engineering-Superheater, Inc., elected Joseph V. Santry, Chairman of the Board. He is succeeded as President by Martens H. Isenberg who was executive Vice-President.

FAWICK

John V. Eakin and Theodore E. Metz have been appointed General Manager and Advertising Manager, respectively, of Fawick Airflex Div. of Federal Fawick Corp., 9919 Clinton Rd., Cleveland 11, Ohio. Mr. Eakin has been with the company since 1943.

COMMONWEALTH

The Commonwealth Engineering Co., Dayton, Ohio, has issued an interesting bulletin "Ideas Into Dollars," which describes the research and development activities of the companies.

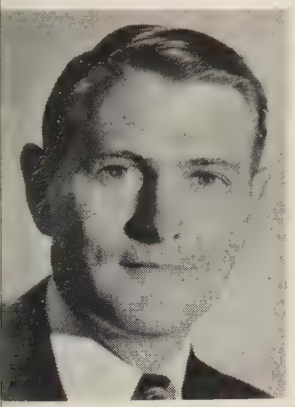
EARL PAINT

Charles B. Weller has been appointed Vice-President in Charge of Industrial Insulation of the Earl Paint Corp., Utica, N. Y. His headquarters will be in Philadelphia. He was formerly with Johns-Manville Corp.

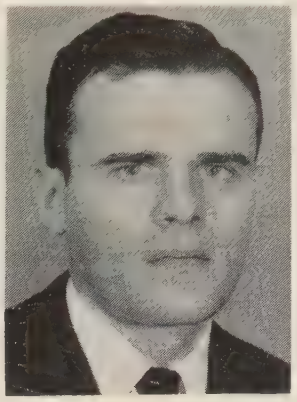
The Whelan Co., 2405 San Jacinto St., Houston, Tex., has been appointed as the Texas sales and engineering representatives of the Earl Paint Corp.

LUKENS

An improved steel plate size selector has been made available by Lukens Steel Co., Coatesville, Pa., for the convenience of designers, engineers, and others interested in steel fabrication.



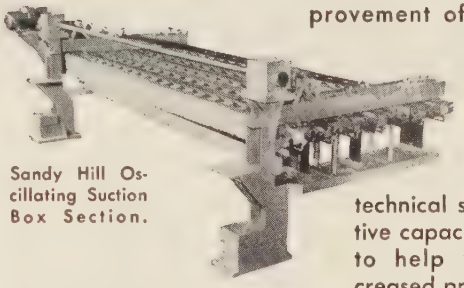
J. V. Eakin, Federal Fawick Corp.



T. E. Metz, Federal Fawick Corp.

Modernization for Specialization

SANDY HILL is ready and equipped to serve you, whether your individual requirement is a new paper machine for a highly specialized purpose or the installation of new facilities for the improvement of existing mills.



Sandy Hill Oscillating Suction Box Section.

Whatever your problem may be, Sandy Hill's technical skill and productive capacity are available to help you attain increased production of high quality paper, economically and profitably.

Consult us at any time, on any problem, without obligation.

The Sandy Hill IRON & BRASS WORKS

PAPER MACHINERY SPECIALISTS • HUDSON FALLS, N. Y.

Associated with Canadian Vickers, Ltd., Montreal, Builders of Sandy Hill Designed Machinery in Canada

When you need

Gelling agents
Asphaltic products for lamination
Carbon blacks for color
Stearates for water-resistance and plasticization

You can depend on WITCO

. . . for a pure, uniform product
. . . for quick, friendly service
. . . for expert technical assistance

Witco products, manufactured in our own modern plants under strictest quality control, are *job-designed* to meet your needs. A note to any of Witco's offices will command our instant attention. Write today.

WITCO CHEMICAL COMPANY

260 Madison Avenue
New York 16, N. Y.

Los Angeles • Boston • Chicago • Houston • Cleveland
San Francisco • Akron • London and Manchester, England

The DRAPER Felt
DRAPER BROTHERS COMPANY
CANTON, MASS.

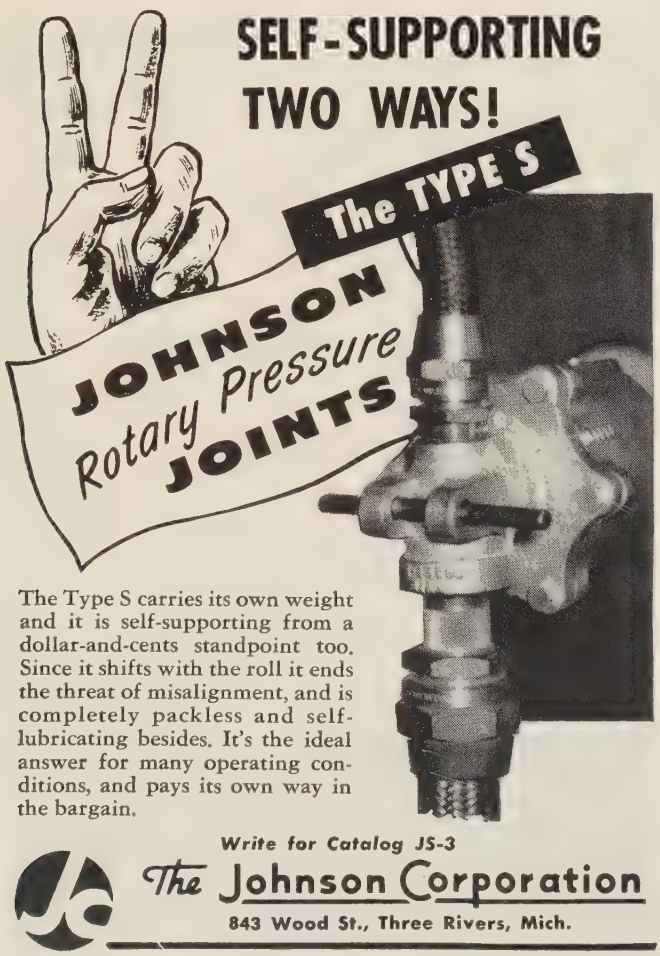
The size selector is a durably-made plastic slide rule that determines the longest and widest steel plates obtainable in any desired thickness from Lukens facilities. These sizes range from 24 to 195 in. in width, or from $^3/_{16}$ to 25 in. in thickness. The reverse side of the selector permits the calculation of weights of rectangular and circular steel plates. A table of decimal equivalents and weights is also included.

G.E.

The General Electric Co., Schenectady, N. Y., has issued a new bulletin GEA-1437H, on "Gear Motors."

H. K. Ferguson

Wayne S. McDaniel has been appointed Chief Engineer of the Eastern District of H. K. Ferguson Co. located in New York, N. Y.



The Type S carries its own weight and it is self-supporting from a dollar-and-cents standpoint too. Since it shifts with the roll it ends the threat of misalignment, and is completely packless and self-lubricating besides. It's the ideal answer for many operating conditions, and pays its own way in the bargain.

Write for Catalog JS-3
The Johnson Corporation
843 Wood St., Three Rivers, Mich.

The company has issued an interesting 12-page brochure describing some of the research and control laboratories designed, constructed, and equipped by the H. K. Ferguson Co.

C. B. & I.

George S. Sangdahl has been elected Vice-President of the Chicago Bridge & Iron Co., 332 S. Michigan Ave., Chicago, Ill. He has been associated with the company since 1915.

National Starch

The U. S. Navy has awarded National Starch Products, Inc., a contract for further research and development work to produce an improved adhesive for the bonding of palletized unit loads; and to investigate and develop improved methods of adhesive application so as to extend the use by Armed Services and industry of this efficient method of handling and shipping supplies; to make a study and evaluate the acceptability of adhesives now being manufactured for palletizing.

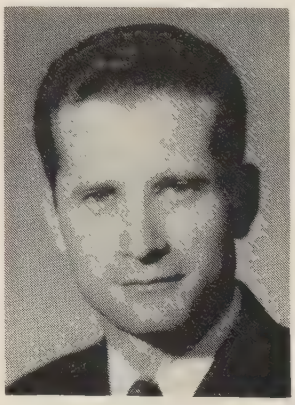
Donald D. Pascal and Herbert C. Piel, Vice-Presidents, have been elected to the Board of Directors of National Starch Products, Inc.

Oldbury

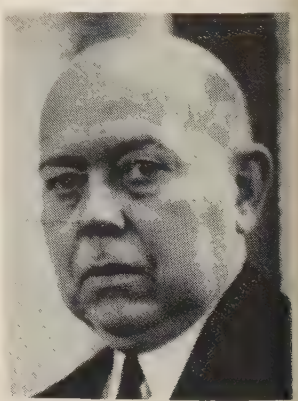
Earl L. Whitford, President of Oldbury Electro-Chemical Co., announced that at the annual meeting of the Board of Directors of Oldbury Electro-Chemical Co., four members of the staff were elevated to office of Vice-President:

Dr. C. A. Stiegman, who has been with the company since 1937, was elected Vice-President and Technical Director. Dr. Stiegman will also continue to serve the company as Secretary.

M. L. Parker, who started in the Research and Development Div. in 1929 and for the past several years has been



D. D. Pascal, National Starch Products, Inc.



H. C. Piel, National Starch Products, Inc.

Production Manager, was elected Vice-President in Charge of Production.

Harold L. Townsend, who has been Chief Engineer of the company since 1940, was elected Vice-President in Charge of Engineering.

N. Harold Fyffe, who came with the company as Assistant Sales Manager in 1936 and has more recently served as Sales Manager, was elected Vice-President in Charge of Sales.

No other changes were effected in the official personnel. Dr. Earl L. Whitford will continue as President and Treasurer, and Dr. Marion B. Geiger continues as Executive Vice-President and Assistant Treasurer.

Chlorine

Pulp and paper mills aided by DPA certificates have been active in boosting their electrolytic capacities or installing new facilities to meet their caustic and chlorine requirements for pulping and bleaching.

These cells of 10 to 25 tons per day capacity, now account for 10% of all chlorine output. For such plants the feasibility of manufacturing vs. buying caustic and chlorine varies with plant size, kind of pulping, and distance from the suppliers. In the Pacific Northwest most mills find it cheaper to buy from Hooker and Pennsalt; in other sections, mills will often make their own, especially where long hauls are involved.

Following are the leading U. S. private chlorine producers and estimated plant capacities:

Producers	*Location*	*Capacity by mid 1954*	*Total tons per day*
Dow Chemical Co.	Midland, Mich.	525	2180
	Freeport-Velasco, Tex.	1450	
	Pittsburg, Calif.	205	
Columbia-Southern (Pittsburgh Plate)	Lake Charles, La.	400	1310
	Corpus Christi, Tex.	225	
	Natrium, W. Va.	450	
	Barberton, Ohio	235	
Diamond Alkali	Pasadena, Tex.	425	725
	Painesville, Ohio	160	
	Pine Bluff, Ark.[a]	70	
	Edgewood Arsenal, Md.[a]	70	
Hooker Electrochemical	Niagara Falls, N. Y.	225	505
	Tacoma, Wash.	180	
	Montague, Mich.	100	
Solvay Process (Allied)	Syracuse, N. Y.	155	480
	Moundsville, W. Va.	175	
	Baton Rouge, La.	75	
	Hopewell, Va.	75	
Pennsylvania Salt Manufacturing	Wyandotte, Mich.	225	485
	Tacoma, Wash.	100	
	Portland, Ore.	85	
	Calvert City, Ky.	75	
Mathieson Chemical	Niagara Falls, N. Y.	120	455
	Saltville, Va.	225	
	McIntosh, Ala.	110	
Wyandotte Chemical	Wyandotte, Mich.	450	450
Stauffer Chemical	Niagara Falls, N. Y.	125	400
	Henderson, Nev.	275	
Westvaco (Food Machy.)	South Charleston, W. Va.	375	375
Monsanto Chemical	East St. Louis, Ill.	175	200
	Anniston, Ala.	25	
Ethyl Corp.	Baton Rouge, La.	120	195
	Houston, Tex.	75	
National Distillers	Ashtabula, Ohio	75	175
	Huntsville, Ala.[a]	100	
Du Pont	Niagara Falls, N. Y.	120	145
	Deepwater Point, N. J.	25	
Niagara Alkali	Niagara Falls, N. Y.	125	125
Shell Chemical	Denver, Colo.[a]	100	100
			8305

[a] Leased from government.

Niagara Alkali

James E. Ferris and M. F. McCombs have been appointed Director of Sales and Manager of Chlor-Alkali Sales of the Niagara Alkali Co., Niagara Falls, N. Y.

Monsanto

T. C. Tupper, Sales Manager of the Monsanto Chemical Co., 1700 S. 2nd St., St. Louis 4, Mo., predicts that synthetic resin adhesives within 5 years will account for 80% of the total adhesives sales to the packaging industry.

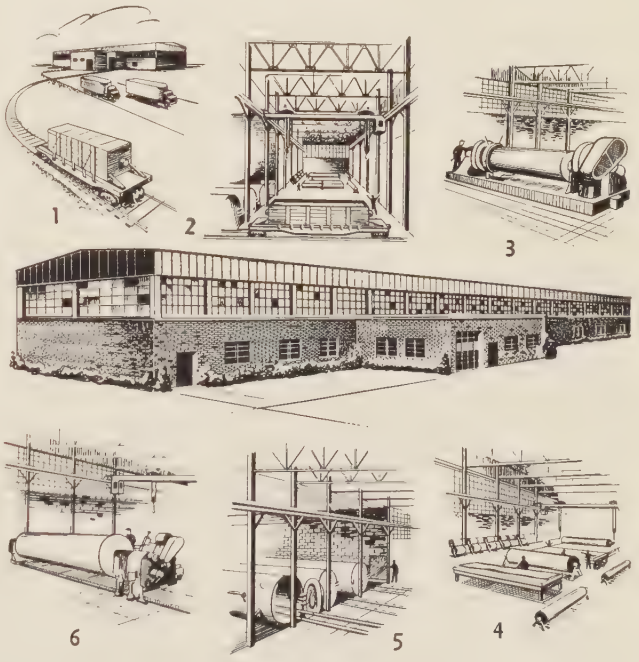
Three interesting bulletins have been issued by Monsanto: No. 0-99 "Monsanto Plasticizers in Synthetic Resin Adhesives"; 0-1 "Santobrite for the Preservation of Water Base Adhesives"; and 0-23 "Santobrite-Sodium Pentochlorophenate."

Reliance

The Reliance Electric & Engineering Co. has opened a new branch office at 13 W. 25th St., Baltimore, Md. The office will be staffed by A. C. Schettler and W. C. Mitchell.

Raybestos-Manhattan

Opening of a new, modern rubber roll covering plant for its subsidiary, The Manhattan Rubber Manufacturing Co., at Neenah, Wis., has been announced by Raybestos-Manhattan, Inc., Passaic, N. J. The new plant expands existing facilities for rubber covering rolls for the paper and other industries in the Midwest.



New Manhattan roll plant and modern precision and efficient handling facilities: 1. shipping and receiving; 2. roll handling system; 3. preparing roll core; 4. rubber covering; 5. vulcanizer; 6. grinding and crowning

The new high single-story plant is built specifically for precision and efficient handling of roll coverings. It is laid out for straight-line production with a modern materials handling system and specially built machinery to handle the largest size rolls. Its location on a large tract of land permits expansion to meet all foreseeable needs of the paper industry.

Being on the Chicago Northwestern Railroad with a siding and on a highway, rolls come directly into the bay area of the plant where they are picked up by overhead cranes on which they can be transported in full length of the plant for straight-line production. Rolls are carried by cranes to cut-off lathes for removing old covering and preparing metal surfaces. All rolls are then precision checked for correct balance. They then go to the covering section, a highly skilled operation on which satisfactory performance of huge papermaking machinery depends.

Rolls then move on cross-shop transfer tracks into vulcanizers equipped with precision temperature and time controls to assure correct curing and accurate density. Grinders handle all roll sizes including the largest rubber-covered rolls in use today. After grinding and crowning, rolls are again precision checked for density, dimensions, and static balance, and where requested they may be dynamically balanced at required operating speeds.

The Manhattan Rubber Manufacturing Co. has been located in Neenah for 20 years, rubber covering rolls for the paper industry in the Fox River Valley of Wisconsin. It was established as an auxiliary of the Manhattan Rubber Div. of Raybestos-Manhattan, Inc., at Passaic, N. J., where paper mill and other rolls have been rubber covered for 60 years. A third large roll covering plant is also operated at North Charleston, S. C., to serve the paper and textile industries in the South.

This construction is in line with the policy of strengthening the Midwest position of the corporation, of which the Neenah company is a part. Another new plant is the Wabash Div. recently constructed at Crawfordsville, Ind., and in operation over a year.

Other operating units of Raybestos-Manhattan, Inc., making rubber and asbestos products for the paper industry are: Raybestos Div., Stratford, Conn., U. S. Asbestos-Grey-Rock Div., Manheim, Pa., General Asbestos & Rubber Div., North Charleston, S. C. There is also a Canadian plant, Canadian Raybestos Co., Ltd., Peterborough, Ont.

American Defibrator

The development of a new feeding device for the introduction of wood chips and other lignocellulose raw materials into high-pressure cooking or preheating vessels has recently been completed by American Defibrator, Inc., 405 Lexington Ave., New York 17, N. Y. The new feeder, under development for several years, was designed primarily for semichemical operations using the Asplund Defibrator.

The new apparatus is essentially a cylindrical rotary valve. This valve consists of a housing and a rotor containing two spherical-shaped pockets. It is mounted with its axis horizontal. The raw material is fed into these pockets in their uppermost position, and when the rotor is turned 180°, the content drops into the receiving vessel. The rotor turns in a specially designed housing with stuffing boxes to prevent escape of steam, and is supported by anti-friction bearings. Lateral movement is held to a minimum by a special mounting arrangement.

Rotor and housing liner are made of materials proved suitable in actual operation. Particular attention has been paid to the close tolerances required for the thermal expansion as well as mechanical deflections and consequent stresses.

The rotary feeder is now available in two sizes: 15 and 21 in. in diameter. The latter size has a capacity of approximately 1 cu. ft. of material per revolution. This unit handles from 70 to 100 tons of wood chips (oven-dry basis) per 24 hours at a speed of only 8 to 12 r.p.m. It is designed to operate against steam pressures up to 180 p.s.i. Power consumption is only 2 to 5 hp. and steam loss is negligible.

Among the advantages possessed by the rotary feeder over the conventional screw feed heretofore employed for continuous semichemical pulping are, in addition to its low power consumption, that it provides for a positive steam seal. No compression or plug-forming of the chips, with consequent deformation of the individual particles, is required. Furthermore, when the wood chips have undergone a pretreatment, e.g., presoaking in a chemical solution, no undesirable and harmful squeezing out of the impregnating liquor takes place, and all chemicals picked up by the wood chips are carried into the steam or cooking vessel.

The development of this rotary feeder now makes possible the continuous cooking of wood chips and other lignocellulose raw materials in more than one pressure zone and opens up new possibilities to produce chemical pulps by continuous processes.

Sandy Hill

Two thousand dollars in United States Savings Bonds were given as a suggestion award to Julius J. Colvin of Hudson Falls, N. Y., by his employer, The Sandy Hill Iron & Brass Works, as an initial payment on an invention which provides for the quick release or replacement of plates in the Packer flat screen and entirely eliminates the multiple screws previously used as plate fasteners.

Julius J. Colvin holds his model of a Quikloc device for screen plate hold-down while Joseph Levesque, president of the Sandy Hill Club holds the four $500.00 bonds awarded Mr. Colvin as initial payment

The mechanism to be known as the Sandy Quickloc screen vat is a quick locking arrangement which offers a simple method for securing the screen plates.

In addition to the time-saving element offered by this quick release feature the new method assures increased plate life because there will no longer be any reason to practice the custom of walking on the plates while releasing or tightening.

Several of these units are already in mill operation and they are proving singularly satisfactory.

Sandy Hill's Packer Screens

The beautiful original wood engraving of a scene from the Vermont hills appearing on The Sandy Hill Iron & Brass Works 1952 Christmas Greeting was as a pebble dropped into a pool starting many unexpected circles of reaction.

D. C. Everest, Chairman of the Board of Marathon Corp., sent a grateful acknowledgment and added a postscript which read, "You may not know it, but I was once a salesman for Sandy Hill screens (1907–08)." We did not know it, but we do know of Mr. Everest's importance in the paper industry today; we do know of his long years of leadership in the growth and development of the Marathon Corp., and it was with some hesitation that we decided to impose on his valuable time by asking him to tell us of his early connections with Sandy Hill.

The cordiality of Mr. Everest's reply offered ample proof of the quality of humanity that contributed much to his climb to the heights. Not only did he tell us of his early connections as a salesman to the pulp and paper trade, but he also forwarded copies of preliminary correspondence and a contract dated November, 1909, for the sale of 25 12-plate Packer screens to the Marathon Corp., for installation at their plant at Rothschild, Wis. This old correspondence and contract bears the name of R. C. Tefft, then President of The Sandy Hill Iron & Brass Works, and father of the present Chairman of the Board, Richard C. Tefft, Jr. Mr. Everest was then Manager of that mill.

Mr. Everest commented that the old contract would indicate that, "things have changed." His reference was to the contract price of $310 per screen—without vats, but his remarks might well have referred to the evolution of the Packer screen of 1909 to the Packer Superscreen of 1953.

It was in 1906 that Sandy Hill's shop superintendent, whose inventive mind bordered on genius, produced for the pulp and paper industry a new type of flat screen that was to revolutionize traditional methods of dirt removal and fiber grinding in pulp stock. Packer's screen won such widespread acceptance that it was soon to be recognized as standard equipment wherever paper was made. Imitators were quick to produce a variety of flat screen models. But imitators could not and never have been able to capture Packer's secret.

Packer's screen of 1909 was, we are sure, the best flat screen on the market of that day. But, Sandy Hill's practical engineers, with their intimate understanding of paper mill techniques and requirements, have added to the original Packer design many mechanical improvements and modifications that have increased the efficiency, capacity, adaptability, and service life of the screen and greatly simplified its operation and maintenance.

Another Sandy Hill Shop Superintendent, Carl Fancher, modernized Packer's toe block agitating method around 1924 without altering Packer's screening principles. Cast steel roller shoes and forged steel cams proved superior to the earlier toe block drive. The roller shoe, having a rolling instead of a dragging motion on the cam, provided a much smoother action and a substantial saving in power.

Then, shortly after the close of World War II, William M. Leeson, long-time Chief Engineer at Sandy Hill, and his protégé, Millard F. Hayes, Jr., were ready to put into production a new totally enclosed roller shoe unit with a continuous oiling system. Again, this unit preserved the Packer principle while providing a mechanism that met with the latest thinking in machine streamlining.

Industry's trend toward all metal construction had already been recognized and Sandy Hill's Packer Screen was being offered with all metal, noncorrosive vats, frames, and flow boxes. To quote Mr. Everest, "Things have changed."

Probably one of the best features of all, so far as the papermaker who was still successfully operating Packer screens built even earlier than the 1909 screens that went to the Marathon mill, was the interchangeability of any or all of the new features. Like the lady knitter who prolonged the life of her husband's hand-knit socks by knitting in first new heels, then new toes, and finally new tops, the operators of Packer screens found that their old screens became modern by the piecemeal addition of the modern features.

American Polymer

On Thursday, April 30, at 2:00 p.m., an unfortunate explosion occurred at the plant of the American Polymer Corp. in Peabody, Mass. The cause is under investigation and is unknown at this time.

The American Polymer plant has been rebuilt. In the meantime the customers were served by other plants located at Leominster, Mass., Illiopolis, Ill., and Toronto, Canada.

American Polymer Corp. produces polyvinyl acetate emulsions and solutions, acrylic emulsions, and solutions and many other products used by the textile, paper, rubber, chemical, and adhesive industries.

One man, Fred Lawson, was fatally injured at the time of the accident. Two others are hospitalized with serious injuries but are expected to recover. All others injured are reported to be improving and expected to be out of danger shortly.

The American Resinous Chemicals plant is intact and shipments to all customers were resumed on Monday, May 4. American Resinous Chemicals serves customers in the textile, paper, rubber, adhesive, and chemical industries and manufactures emulsions, solutions, and hot melts which are used as adhesives, coatings, binders, saturants, and sizings.

Staley

Tronie A. Bailey has been appointed Senior Technical Representative of the A. E. Staley Mfg. Co., Decatur, Ill., to work with the corrugating industry.

Becco

H. O. Kauffman has been appointed Technical Director of the Buffalo Electro-Chemical Co., Buffalo, N. Y. Other appointments include: E. S. Shanley, Assistant Technical Director; P. H. Margulies, Technical Information and Patents; L. H. Dawsey, Manager of Process Research; F. P. Greenspan, Manager of Organic Research and Development; R. L. McEwen, Manager of Pulp and Paper Research and Development; and B. K. Easton, Supervisor of Textile Research.

D. J. Murray

D. J. Murray Mfg. Co., Wausau, Wis., has announced a new V-spout for pulpwood chippers. Regardless of the make of the chipper, the Murco V-type spout will fit it. Because of its specially designed shape the spout will hold any size stick or log. The wood moves in a straight line without side movement to retard cutting.

The new D. J. Murray V-spout for pulpwood chippers

D. J. Murray is now marketing the Murco-Mosinee automatic digester stock sampler. With this equipment it is possible to know where shives and poorly rooked pulp are being made, and can use corrective measures on the next cook.

TAPPI DIVISIONS AND COMMITTEES

Reports of Activities

Nonfibrous Materials Testing Committee

Testing of Animal Glue

K. H. Williams, Chief Chemist of Mid-States Gummed Paper Co., is the committee chairman on glue testing. The other committee members include L. B. Tucker (Crane), C. S. Young (Swift), and R. Tutt (Peter Cooper). Two more men from the paper industry are to be added to this committee. A meeting of committee members was held at the time of the Annual TAPPI Meeting and it was agreed that a set of specifications would be drawn up for the following methods of testing animal glue:

1. Viscosity.
2. Gel strength.
3. Total grease.
4. Foam.
5. pH.
6. Keeping quality.
7. Moisture content.
8. Insolubles.

It was also agreed that the following groups would be contacted to figure the factual material necessary for drawing up suitable specifications:

(a) A selected list of paper manufacturers who produce the types of paper where glue is employed.
(b) Manufacturers of glue.
(c) Gummed industry converters.

The committee is in the process of contacting these various groups and as soon as the necessary material is obtained it will be forwarded to the committee members for their discussion and evaluation.

Testing of Rosin and Rosin Size

The activities of the Rosin Size and Rosin Committee under the direction of D. D. Cameron as chairman are just about complete. The revised method for analysis of rosin size has already been submitted to the Standards Committee and published in *Tappi*. A few minor revisions need to be made in the method for analysis of rosin and as soon as these are complete the revised method will be forwarded to the Standards Committee.

Testing of Clays

The Clay Committee under the direction of C. G. Albert continues to be very active and has drawn up a number of methods for the testing of clay. The committee membership at the present time is as follows:

C. G. Albert, Chairman, Edgar Bros. Co.
R. Billue, Thiele Kaolin Co.
R. B. Blakeslee, Imperial Paper & Color Corp.
C. W. Clark, St. Regis Paper Co.
H. F. Kohne, West Virginia Pulp & Paper Co.
I. L. Lester, Georgia Kaolin Co.
Nathan Millman, The Huber Co.
K. F. Miles, Mead Corp.
M. R. Wilkins, Kalamazoo Paper Co.

The methods which have already been prepared include:

1. Sampling.
2. Moisture.
3. pH value.
4. Grit.
5. Particle size distribution.
6. Brightness.
7. Disintegration of coating clay.
8. Viscosity of coating clay.

Originally, it was planned to include all of these in one method, but this would make such a very long method that it has been decided to prepare several methods. One of these will be titled "Testing of Clay" and will include tests for sampling, moisture, pH, and grit. Separate methods for particle size distribution, brightness, disintegration, and viscosity are in the process of being written up and an effort is being made to make these methods broad enough so that they will apply to all pigments used in the paper field.

Good agreement has been reached by committee members on all methods except for particle size measurement. The committee is making a study of methods for particle size measurement, including some round-robin testing, and hopes to reach an agreement within the subcommittee on this method by Summer. The methods under consideration include two different procedures involving hydrometers and a procedure involving a pipet. It is hoped that a single procedure can be agreed upon as the standard method.

Testing of Calcium Sulphate

The method, "Analysis of Calcium Sulphate Fillers," has been rewritten and submitted to the Standards Committee. Work on this method is now complete.

Testing of Opaque Pigments

Opaque Pigments Subcommittee has been formed under the chairmanship of W. R. Willets. Other members of this committee are:

H. C. Brill, E. I. du Pont de Nemours & Co.
V. A. Belcher, New Jersey Zinc Co.
F. O. Sundstrom, American Cyanamid Co.
F. H. Denham, R. T. Vanderbilt Co.

To date only informal discussions of the committee have been held and no definite start has been made in formulating testing methods. It was decided that all opaque pigments should be considered jointly, although methods for the chemical analyses for zinc and titanium pigments would obviously differ. The committee members are at the present time reviewing the available material in ASTM standards, TAPPI standards, and elsewhere pertaining to the testing of fillers and pigments.

The committee is waiting for the write-up on the clay methods which should be ready in the near future. They plan to study these methods carefully to determine which of these tests will be applicable to opaque pigments, as well as to clay.

Testing of Casein

The Casein Subcommittee under the chairmanship of D. B. Laird has been moving rather slowly and has nothing new to report at this time. An effort is being made, however, to revise or to bring the method for the testing of casein up to date, and it is hoped that this can be done very soon.

Testing of Enzymes

The Enzyme Committee under the direction of A. Frieden has prepared two methods for testing enzyme activity. One of these is a viscosity method and the other is a photometric method. Roger Griffin has examined these methods and made the suggestion that the viscosity method be included

in the routine control methods, and that only the photometric method be considered for TAPPI standards. The photometric method is in the process of being revised editorially and will be sent back to the Enzyme Committee for consideration as a single proposed method for TAPPI standards. There is still considerable work which will be needed to complete the preparation of this enzyme method.

James P. Casey, *Chairman*

Packaging Materials Testing Committee

The joint TAPPI-Packaging Institute Materials Testing Committee met on Feb. 16, 1953. Five committee members were present from a membership list of 22, and the total attendance was 9. James Clark appointed Wm. H. Aiken as chairman of the committee to replace L. E. Simerl, who recently resigned. The following projects were discussed.

No. 277—Water Vapor Permeability at 0°F.

This method has been issued. The project is, therefore, closed for the time being.

No. 387—Water Vapor Permeability at 100°F. and 90% Relative Humidity

Charles Southwick resigned as chairman of the subcommittee handling this project, due to pressure of activities in his new position. T. E. Dobbins of American Can Co. was appointed to replace him.

Phillip Barnhart confirmed the report of the September meeting that the Technical Committee on the Greaseproof and Glassine Association have carried on round-robin tests with the General Foods cabinet for several years and get results which check within 10 to 12%. A review of this experience should be helpful in revising TAPPI Standard T 464 m–45 in order that more reproducible results may be obtained between different laboratories. The Greaseproof and Glassine Association will be contacted officially through TAPPI for this information.

There was considerable discussion about the fact that two TAPPI Standards (T 448 m-49 and T 464 m-45) relating to water vapor permeability have led to some confusion to people just entering the packaging field. It was agreed that T 448 m-49 is not generally applicable to packaging materials, but is of more interest to the building materials group. At the time T 464 m-45 is revised, it may be advisable to designate in the title that it is for use on packaging materials.

Creasing of Paper for Water Vapor Permeability Test—T 465 sm-52

There is considerable disagreement as to the value of the method set forth in T 465 sm-52. Companies interested in resin coated and laminated materials feel that the method shows the differences that exist between various materials. There are some who feel that the method is too severe for plain waxed paper. One area of agreement was that the test should be made more mechanical to eliminate human error. The interest in this test warrants considerable investigation. Work between various laboratories will be difficult until reproducible water vapor permeability results can be obtained by the different laboratories on uncreased materials. Work on the creasing method will, therefore, be delayed until T 464 m-45 has been revised.

No. 328—Flavor and Odor Transfer

Arthur Landrock, chairman of the subcommittee, was not present. Two test procedures are now in the rough draft stage.

No. 331—Heat Solubility

In 1946 the Technical Committee of the Packaging Institute suggested a method for measuring heat sealing strength (reprinted in *Modern Packaging*, September, 1946). Apparently there are still many problems to be solved, especially in preparing the seal for testing. There is also some debate as to whether a dead weight or a dynamic test should be used. Recent developments and interest of TAPPI membership will be reviewed.

No. 357—Water Vapor Permeability of Completed Packages

Charles Woodcock, chairman of the subcommittee on this project, was not present. Two procedures are in the rough draft stage.

No. 388—Insect Resistance

Howard Gardner, chairman of the subcommittee on this project, reported that the procedure is still in the rough draft stage.

New Projects

The possibility of a test method to evaluate packages containing vapor phase inhibiting materials was discussed. This will be investigated by various committee members and discussed at a future meeting.

T. E. Dobbins suggested as worthy projects for the committee the preparation of monographs on vapor barriers and on flexible packaging materials. The amount of work involved on such projects was recognized. This subject will be carefully investigated before it is taken on as a project.

William H. Aiken, *Chairman*

Mechanical Pulping Committee

Fred W. O'Neil, of the College of Forestry, State University of New York, has announced the following personnel of the Mechanical Pulping Committee:

F. W. O'Neil, Chairman, College of Forestry
J. H. Perry, Secretary, Norton Co.
W. H. de Montmorency, Pulp & Paper Research Institute of Canada
Axel Hyttinen, Forest Products Lab.
Milton Jacobs, Chas. T. Main, Inc.
T. F. LaHaise, Imperial Paper & Color Corp.
R. L. Leaf, Jr., Little Rapids Pulp Co.
E. H. Johnson, Stevens & Thomson Paper Co.
J. K. Kirkpatrick, Champion Paper & Fibre Co.
T. E. Kloss, Hollingsworth & Whitney Co.
R. S. Magruder, Paper Corp. of America
K. L. Pingrey, The Diamond Match Co.
J. H. White, Keyes Fibre Co.

Fred W. O'Neil, *Chairman*

Semichemical Pulping Committee

J. N. McGovern of the Forest Products Laboratory, Madison, Wis., has announced the following personnel of the Semichemical Pulping Committee:

J. N. McGovern, Chairman, Forest Products Lab., Madison 5, Wis.
C. W. Converse, Secretary, Sprout, Waldron & Co., Muncy, Pa.
R. W. Brown, Hammermill Paper Co., Erie, Pa.
W. T. Butler, Abitibi Power & Paper Co., Ltd., Sault Ste. Marie, Ont., Canada
E. D. Cann, Howard Smith Paper Mills, Ltd., Cornwall, Ont., Canada
R. G. Coker, Sonoco Products Co., Hartsville, S. C.
E. S. Flinn, The Mead Corp., Chillicothe, Ohio
P. L. Gilmont, Crossett Paper Co., Crossett, Ark.
J. S. Hart, Pulp and Paper Research Institute of Canada, Montreal 2, Canada
Gerald Haywood, West Virginia Pulp and Paper Co., Luke, Md.
G. C. Kimble, Union Bag & Paper Corp., Savannah, Ga.
R. G. Knechtges, The American Pulp and Paper Co., Filer City, Mich.
D. J. MacLaurin, Institute of Paper Chemistry, Appleton, Wis.
W. W. Marteny, National Container Corp., Tomahawk, Wis.
S. R. Parsons, Consolidated Water Power and Paper Co., Wisconsin Rapids, Wis.

J. E. Sapp, Gaylord Container Corp., Gogalusa, La.
J. A. Staidl, Camp Manufacturing Co., Franklin, Va.
C. K. Textor, The Bauer Brothers Co., Springfield, Ohio
S. A. Woodruff, Battelle Memorial Institute, Columbus, Ohio

Equipment Survey Subcommittee

J. E. Sapp, Chairman
R. G. Coker
E. S. Flinn
D. J. MacLaurin
J. A. Staidl

Standard Terms Subcommittee

C. K. Textor
P. L. Gilmont
Gerald Haywood
W. W. Marteny

News Note Subcommittee

C. W. Converse, Chairman

Semichemical Pulping Measures Subcommittee

R. W. Brown, Chairman
W. T. Butler
E. D. Cann
J. S. Hart
G. C. Kimble
R. G. Knechtges
S. R. Parsons

Bibliography and Review Subcommittee

J. N. McGovern, Chairman
S. A. Woodruff

The annual meeting of the committee was held at 2:00 p.m., Feb. 17, 1953, under the chairmanship of J. N. McGovern with the following present:

J. A. Staidl,* Camp Manufacturing Co.
S. A. Woodruff,* Battelle Memorial Institute
J. W. Baymiller, Armstrong Cork Co.
J. E. Copenhaver, Sonoco Products Co.
J. F. Stevenson, The Mead Corp.
C. K. Textor,* Bauer Brothers Co.
R. W. Brown,* Hammermill Paper Co.
R. G. Knechtges,* American Box Board Co.
R. H. Rasch, Hammermill Paper Co.
J. W. Sparrow, Scott Paper Co.
W. A. Kraske, Solvay Process Div., Allied Chemical & Dye Co.
B. E. Helberg, Lion Oil Co.
P. L. Gilmont,* Crossett Paper Mills
R. C. Sproull, Herty Foundation Laboratory
R. E. Collins, Sprout, Waldron & Co., Inc.
D. B. Kuhe, Crossett Paper Mills
R. B. Elliott, Du Pont Co.
J. J. Owen, Union Bag & Paper Corp.
W. T. Butler,* Abitibi Power & Paper Co., Ltd.
D. J. McLaurin,* Institute of Paper Chemistry
J. S. Hart,* Pulp & Paper Research Institute of Canada
W. K. Voss, Ontario Paper Co., Ltd.
A. G. Durgin, St. Lawrence Corp.
G. A. Franklin, Ontario Paper Co., Ltd.
S. A. Parsons,* Consolidated Water Power & Paper Co.
R. E. Bowen, North Carolina Pulp Co.
J. N. McGovern,* Forest Products Lab.
C. W. Converse,* Sprout, Waldron & Co., Inc.
Henry Schmitz, A. O. Smith Corp.
E. D. Cann,* Howard Smith Paper Mills, Ltd.
E. S. Flinn,* Mead Corp.

The minutes of the previous meeting, Feb. 11, 1952, were read by the secretary, C. W. Converse, and accepted.

Subcommittee reports were as follows:

Equipment Survey (D. J. McLaurin reported in the absence of J. E. Sapp): A questionnaire covering equipment and process practice has been drafted and twice revised. It is now ready to be sent to all semichemical pulp mills in North America. It was agreed that the questionnaire should be issued as soon as possible. The point was made that it must be answered completely and conscientiously by the recipients to make the information worth while to the committee.

Semichemical Measures (R. W. Brown, subcommittee chairman, reported): the current fields of interest for this subcommittee are as follows:

1. Degree of cooking.
   (a) Permanganate number.
   (b) Chip softness.
   (c) Lignin content.
2. Degree of refining.
3. Analysis of cooking liquor.

* Committee Members.

A questionnaire was prepared for possible issuance to all semichemical pulp mills, requesting information on:

1. Cooking methods.
2. Refining control tests.
3. Cooking liquor analysis methods.

However, it was agreed that the information requested should not duplicate that requested in the Equipment Survey and that consideration be given to combining the questionnaires.

J. S. Hart of the Pulp & Paper Research Institute of Canada discussed a new method which they are studying for the evaluation of the degree of cooking as follows: We are using the laboratory Dynopulper as a means of measuring what we have termed the cohesiveness of the cooked charge as expressed by the ratio of stock accepted to the stock rejected on an appropriate screen after the charge has received a standardized treatment in the said Dynopulper (the stock rejected will consist of knots and imperfectly digested chips; while the stock accepted will consist of uniformly digested chips, fiber bundles, and fibers). The measure (that is the quantitative value) of this property of the cooked charge when separated under an appropriate screen after this processing, has been termed the cohesive rating. The exact means for computing this quantitative value has not yet been finalized.

The laboratory Dynopulper as produced by the Rice-Barton Research Corp. was altered in several respects, the major one being the redesigning of the impellers so that results could be accurately reproduced. Following tihese changes, results could be duplicated within very narrow lmits.

The procedure for testing pulps is summarized in the following steps:

(a) One pound, 454 grams, of moisture-free semichemical chips are placed in the Dynopulper at a consistency of approximately $3^1/_2\%$ (it has been found that variations in consistency of 0.5% have made no significant difference to the results).
(b) The run is made for a specified number of minutes which would vary with the condition of the chips, but might be approximately 20 min. for the first run.
(c) Another run is made in which the time is increased or decreased depending on the results from run no. 1.
(d) The pulps from these runs are screened on a 0.100-in. slot screen plate and the rejects dried to a constant weight in the oven.

The method of tabulating the results obtained from these tests has been as follows:

Using semilog paper the per cent of rejects is recorded on the logarithmic scale and the times on the regular scale.

The values for different runs of the same pulp may be joined up and have been found in the work to date to be a straight line. It would appear that the degree of cooking for any one method of pulping might be represented by a series of such lines having the same slope and, therefore, a Cohesive Rating could be determined by a cutoff at a different time interval. On the other hand, when the method of pulping is changed, then the slope of the line also appears to be changed.

There has not been sufficient work done on a wide variety of pulps to establish the trends mentioned. This work is progressing, and it is hoped that in time a correlation might be made between such information and the refining characteristics of the pulp in a commercial refiner.

D. J. McLaurin remarked that somewhat the same method was being investigated at the Institute of Paper Chemistry with a different stirring device. The rejects are a measure of the degree of cooking. As Mr. Hart intimated, the per cent rejects is not a pure function of yield but rather a function of yield and pulping history. There is a unique correlation for a given wood pulp and cooking procedure. The reproducibility of their technique appears hopeful. A 0.010-in. slot screen plate is used.

Further discussion indicated that lignin content had not been determined in relation to cohesiveness because of the difficulty in determining the lignin content of semichemical pulps. Ultraviolet ray analysis is not too satisfactory because too many compounds present have about the same absorption characteristics as lignin.

R. H. Rasch, Hammermill Paper Co., Erie, Pa., reported on the subject of "Bleachability Test for High Yield Pulp." This report is to be published as a separate paper.

Discussion of Mr. Rasch's report brought out the points that at the maximum chlorine demand was not applied in the first stage since other factors such as total chlorine economy are involved; that about 1% more chlorine would be required if the caustic extraction were eliminated, and that the method was being used to control mill and laboratory bleaching. It was mentioned that one mill bleaching a blend of aspen semichemical and coniferous sulphite pulps applied 10% chlorine in the chlorination stage and 5% chlorine in the hypochlorite stage.

Terminology. (C. K. Textor, Subcommittee chairman, submitted the following report): The Subcommittee on Terminology was appointed late in 1952. After discussion of many of the terms, it was decided that the report should be submitted to the full committee membership for comments before taking final action.

Newsnote (C. W. Converse, subcommittee chairman, reported): This publication is circulated only to the Semichemical Pulping Committee members, the general chairman of the pulp manufacturing division, and the Secretary of TAPPI. Its objective is to serve as a clearing house for committee interim reports, problems, and ideas. It depends on the committee members for news and if it is to be successful every member must make an effort to contribute. It is issued quarterly.

Bibliography (J. N. McGovern, subcommittee chairman, reported): A bibliography of semichemical literature for 1952 has been compiled and will be sent to the committee members. It was suggested that the literature on semichemical pulping be reviewed annually in an annotated and indexed form at The Institute of Paper Chemistry through a TAPPI Research Appropriation. The earlier bibliography, No. 175, which was dated March, 1950, would be brought up to date.

This completed the subcommittee reports.

The meeting was turned to new business. The new business started with a discussion of possible projects for suggestion to the Research Appropriation Committee. D. J. McLaurin mentioned that a study had been suggested through the Fundamental Research Committee to determine the forces required to separate planes of wood in a softened chip, relating the data to previous pulping history of the chips. The data will indicate the nature and magnitude of the forces involved and the forces per unit area. It was suggested that the Semichemical Pulping Committee back this project. J. N. McGovern suggested projects on the kinetics of the semichemical pulping reaction to further present work and on a study of the acid sulphite semichemical pulping process. It was decided that the chairman would follow through on consideration of these and other projects for sponsorship by the committee.

The membership indicated that no new activities should be undertaken during the next year.

The question of a separate conference similar in scope to the conferences of other committees was raised. Three possibilities were suggested:

1. A semichemical pulping conference.
2. A joint conference with the Alkaline Pulping Committee.
3. A separate Semichemical Pulping Committee meeting.

It was agreed that the Semichemical Pulping Committee was not prepared to sponsor a full-fledged conference or even to share a conference with the Alkaline Pulping Committee. It was decided to look into the possibility of a committee meeting with a definite program in about 6 months, the time and place to be decided later.

The meeting was adjourned at 4:15 p.m.

J. N. McGovern, *Chairman*
C. W. Converse, *Secretary*

The Subcommittee on Terminology was appointed late in the summer of 1952 and began functioning during the late Autumn.

A list of 20 firms engaged in or contemplating the manufacture of semichemical pulp was contacted to determine just what names or terms needed definition and especially to obtain suggestions for the definition of such terms. This list was prepared hurriedly, and unfortunately was very incomplete.

The response was gratifying; in several cases the reply to our inquiry comprised the combined opinion of several men in an organization. We wish to thank the following for their cooperation:

M. G. Lyon, Champion Paper & Fibre Co.
W. Gallay, B. B. Eddy Co.
Royal Rasch, Hammermill Paper Co.
George Sheets, The Mead Corp.
H. L. Field, West Virginia Pulp & Paper Co.
R. G. Coker, Sonoco Products Co.
W. L. Schnorbach, American Boxboard Co.
R. M. Dorland, Abitibi Power & Paper Co.
G. Haywood, West Virginia Pulp & Paper Co.
W. W. Marteny, National Container Corp.

These suggestions have been edited by your subcommittee and are here presented for your consideration. Comments by those making the suggestions, or by the subcommittee, are included with each definition.

1. Semichemical Pulping

Suggested Definition. Semichemical pulping is a multistage process involving chemical treatment of a fibrous raw material to obtain a softening and partial removal of the lignocellulose bonding material, followed by a mechanical treatment to complete the fiber separation.

Discussion. This definition is taken, with minor change, from Casey (*Pulp and Paper*, p. 206). It places no restrictions on the species of the fibrous raw material, or on the chemicals, either as to proportion or kind. It imposes no limitation on yield of pulp, or on the equipment used for either the chemical or mechanical treatment. But it is thought that this definition excludes the production of high yield pulps when such processes are merely conventional "full cook" procedures in which only the screenings are mechanically treated to convert them into pulp.

2. Fiberizing

Definition. Fiberizing is the mechanical treatment applied to aggregates of fibers by which the aggregates are resolved into a mass of essentially individual fibers.

Discussion. This is the mechanical action that currently is referred to as defibering, defiberizing, fibrating, pulping, refining, and by other similar terms. Ideally, fiberizing would effect the separation of or aggregate into its fibrous components, without changing the character of the individual fibers, by cutting hydrating or other action. Practically, this ideal may never be achieved, but it is contemplated that such other effects are coincidental to, and not part of fiberizing.

3. Names of Various Semichemical Pulping Procedures in Current Use, with Identifying Symbols

(a) Neutral Sulphite Semichemical –NSSC. The chemical treatment in which the principal active agent is sodium sulphite, with or without alkaline buffer.

(b) Kraft Semichemical -KSC. The treatment in which the chemical softening is effected with a solution of caustic soda and sodium sulphide.

(c) Soda Semichemical—SSC. The treatment in which the chemical softening is effected with a solution of caustic soda.

(d) Acid Sulphite Semichemical—ASSC. The procedure in which the active chemical is a solution of free and combined sulphur dioxide.

(e) Chemigroundwood—CGW. The process in which logs are impregnated with chemicals, especially sodium sulphite, with and without a buffer, at elevated temperatures and pressures, prior to conventional grinding.

(f) Cold Soak Caustic Semichemical—CSCS. The process involving the impregnation of the fibrous material in cold caustic soda solution as a preliminary to fiberizing.

(g) For further definition, the name or symbol of the process may be preceded by the name or class of the fibrous material used, such as Hardwood NSSC, pine KSC, or aspen CGW.

4. Refining

Definition. The mechanical treatment given the fiberized pulp, for the purpose of developing its strength or other desired properties.

Discussion. This definition is offered, without enthusiasm, by your subcommittee. It is believed that there should be a term for the action described. In the old practice, this phase was adequately covered by the terms "beating and refining." But beaters are disappearing from the scene, and the term "refining" is very loosely used. In addition the word "refine" is being used increasingly in the sense of purification of pulp.

5. Yield (Per Cent)

Definition. This is expressed as the number of pounds of moisture-free washed pulp obtained from 100 lb. of moisture-free wood.

6. Chemical Charge (Per Cent)

Definition. This is the number of pounds of active chemicals (figured as Na_2Co_3) employed in the softening stage of the process for each 100 lb. of moisture-free wood.

7. Buffer (for NSSC Only)

Definition. A mildly alkaline chemical such as sodium carbonate or sodium bicarbonate which is added in small proportion to the cooking liquor for the purpose of neutralizing the organic acids released from the wood during digestion.

8. Chemical Ratio (for NSSC Only)

Definition. The ratio of active agent (sodium sulphite) to the buffer (sodium carbonate or bicarbonate) when each is expressed as its Na_2Co_3 equivalent.

9. Chemical Efficiency

Definition. The ratio of the total lignin in the raw material, divided into the lignin dissolved by the chemical treatment.

Discussion. Mr. Haywood has worked out an estimating procedure for NSSC, and no doubt a similar procedure can be devised for the other processes.

10. Degree of Cooking

Definition. (None offered.)

Discussion. There are so many grades of semichemical pulp being made that the mere name "semichemical" gives no clue to the probable character of the pulp. The yield figure above defined would serve for some purposes; and a "K number" or other measure of chlorine demand, would probably suffice.

11. Power Consumption (in Mechanical Treatment)

Definition. The power used in the mechanical treatment of the chemically softened material shall be expressed as (1) kw.-hr. per ton of moisture-free pulp, or (2) b.hp. days per ton of air-dry pulp.

Discussion. The first of these figures is generally preferred for accounting and engineering purposes; the second is the practical figure for mill operators, in that the pulp is sold on the air-dry basis and their motors are rated in brake horsepower.

No power figure is completely satisfactory in a technical sense, because there is no available means of determining the degree of completeness of fiberizing, and there is always a substantial amount of quality development work applied to the fiber during the fiberizing operation.

There is an investigation under way to determine the fiberizing characteristics of a pulp by subjecting it to violent agitation. If a such a test proves successful, it will constitute a valuable addition to semichemical pulping technology.

Conclusion

This report is primarily a condensation and editing of comments received from men and organizations who are active in semichemical pulp production or investigation.

The definitions included in the report are presented as suggestions rather than as final recommendations.

It is submitted that the activities of the subcommittee to date have been sketchy and explanatory, but have received encouraging cooperation from the industry. It is recommended that the subject to terminology be discussed by the entire Semichemical Pulping Committee and that the activities of the subcommittee be continued and guided by the sense of such general discussion.

Gerald Haywood
W. W. Marteney
C. K. Textor, *Chairman*

Graphic Arts Committee

The meeting was called to order at 2:40 p.m. by Chairman Elliot. The following members and guests were present:

F. D. Elliot, Time, Inc.
F. A. Weymouth, IPI Div., Interchemical Co.
L. F. Englehart, IPI Div., Interchemical Co.
R. H. Simmons, Government Printing Office
E. R. Duffie, Sun Chemical Co.
G. Larocque, New York *Daily News*
H. M. Annis, Oxford Paper Co.
R. F. Reed, Lithographic Technical Foundation
Iven Ahrenkilde, Research Dept. of the Graphic College of Denmark
R. H. McKee, Columbia University
E. L. Turner, Jr., Gardner Board & Carton Co.
L. G. Zentner, Gardner Board & Carton Co.
W. Verseput, Robert Gair, Inc.
J. Ramsbottom, Andrew Jergens Co.
A. T. Luey, Sutherland Paper Co.
C. A. Morton, West Virginia Pulp & Paper Co.

The minutes of the previous meeting were read and approved. Mr. Elliot was selected to succeed himself as committee chairman. Dr. Larocque was chosen as committee vice-chairman. Mr. Morton was appointed as secretary to the committee and as chairman of the subcommittee responsible for the Monograph on Printing Processes.

Dr. Larocque reported that his organization is investigating the stress-strain relationship of newsprint on the printing press and is developing a recording tensile tester. Dr. Larocque stated that he will have a more complete report on this investigation for next year's TAPPI meeting. Dr. Larocque offered to represent the Graphic Arts Committee of TAPPI at the Second International Conference of the Printing Research Institutes in Sweden in June and will submit a report of these meetings to the committee members.

The chairman read a letter from Martin Galbraith requesting a review of practical control testers which would provide adequate information on either surface strength or internal bonding strength of a sheet of paper inasmuch as Mr. Galbraith feels the wax test (TAPPI Standard T 459 m-48) is not of practical use on papers having thermoplastic binders in coating formulations.

Mr. Weymouth reported that the Printing Ink Research Institute is presently making a study of the available surface strength tests and testers which may be usable to replace the

wax test. The committee agreed to offer PIRI its cooperation on the project in arranging for paper samples to be submitted to PIRI and in other ways which PIRI might request. Mr. Weymouth will act in conjunction with PIRI for the committee. A short discussion of the available testers followed in which Mr. Reed outlined the use of the LTF tester.

The TAPPI Printing Monograph was discussed and it was agreed that Mr. Morton would submit a proposed outline of the Letterpress Section of the Monograph to the committee as soon as possible after receiving the material currently in the possession of Mr. Elliot.

A New York meeting was tentatively planned for April 30.

F. D. Elliot, *Chairman*
C. A. Morton, *Secretary*

Microscopy Committee

C. E. Brandon of Howard Paper Mills has announced the following personnel of the Microscopy Committee:

C. P. Donofrio, New York State College of Forestry, Syracuse, N. Y.
Harold C. Koch, Weston Paper Co., St. Marys, Ohio
R. H. Simmons, Government Printing Office, Washington, D. C.
F. L. Simons, Crane Co., Inc., Dalton, Mass.
Norval F. Wilson, Missisquoi Corp., Sheldon Springs, Vt.
William Landes, Paper & Pulp Testing Labs., New York 16, N. Y.
F. D. Houghton, Box 78, Mendenhall, Pa.
C. G. Coven, American Cyanamid Co., Stamford, Conn.
Irving Isenberg, Institute of Paper Chemistry, Appleton, Wis.
D. V. Lent, W. R. Grace & Co., New York, N. Y.
D. A. Cameron, Alliance Paper Mills, Ltd., Merritton, Ont.
E. R. Wand, Interlake Tissue Mills, Merritton, Ont.
Alton P. Tracy, John A. Manning Paper Co., Troy, N. Y.

C. E. Brandon, *Chairman*

Pulp Purification Committee

W. H. Rapson of the University of Toronto has announced the following personnel of the Pulp Purification Committee:

W. H. Rapson, Chairman,
R. L. McEwen, Secretary
P. E. Burchfield, Wyandotte Chemicals Corp.
Ferri Casciani, Niagara Alkali Co.
F. P. Doane, Bergstrom Paper Co.
V. P. Edwardes, Corinth, N. Y.
L. V. Forman, Scott Paper Co.
K. W. Fries, Rhinelander Paper Co.
W. D. Harrison, Riegel Paper Corp.
Emil Heuser, La Jolla, Calif.
R. P. Hill, Pulp Bleaching Corp.
R. M. Husband, University of Toronto
E. L. Jones, Hercules Powder Co.
Ferdinand Kraft, Marathon Paper Mills
G. H. McGregor, Minnesota & Ontario Paper Co.
D. H. McMurtrie, Brown Co.
R. W. Miller, Pacific Lumber Co.
W. H. Monsson, Hooker Electrochemical Co.
P. E. Nethercut, Scott Paper Co.
J. K. Perkins, Improved Paper Machinery Corp.
R. K. Prince, Allis-Chalmers Mfg. Co.
J. S. Reichert, E. I. du Pont de Nemours Co.
John Schuber, Solvay Process Corp.
F. A. Simmonds, Forest Products Laboratory
Morris Wayman,
Vernon Woodside, Mathieson Chemical Co.

The project for this year will be to prepare a full day symposium for the next Annual Meeting, on the subject of Pulp Bleaching and Purification. This will take the form of 4 papers on selected subjects, preferably by speakers from pulp manufacturing companies with research experience, in the morning, and a discussion in the afternoon, led by a panel of experts in various phases of the subject, perhaps from among the committee members.

W. H. Rapson, *Chairman*

Preparation of Papermaking Materials Committee

F. S. Klein of Byron Weston Co. has announced the following personnel of the Preparation of Papermaking Materials Committee:

F. S. Klein, Chairman,
J. P. Bainbridge, Jr., Secretary,
W. E. Carson, Whiting-Plover Paper Co.
John Lewis, Lowell Textile Inst.
R. G. Mispley, Crown Zellerbach Corp.
F. L. Simons, Crane & Co., Inc.
E. W. Strecker, Esleeck Mfg. Co.
J. F. Theriault, Robt. Gair Co.

Significance of Sizing Tests Subcommittee

R. G. Mispley, Chairman, Crown Zellerbach Corp.
J. P. Bainbridge, Monsanto Chemical Co.
W. E. Carlson, Whiting-Plover Paper Co.
F. S. Klein, Byron Weston Co.
E. W. Strecker, Esleeck Mfg. Co.

Filler Monograph Subcommittee

J. F. Theriault, Robt. Gair Co.
J. P. Bainbridge, Monsanto Chemical Co.

Preparation of Small Materials Monograph Subcommittee

J. P. Bainbridge, Monsanto Chemical Co.
W. E. Carlson, Whiting-Plover Paper Co.
F. S. Klein, Byron Weston Co.
E. W. Strecker, Esleeck Mfg. Co.

F. S. Klein, *Chairman*

Training and Education Committee

J. H. Groves of Union Bag & Paper Corp. has announced the following personnel of the Training and Education Committee:

J. A. Luke, West Virginia Pulp & Paper Co., Erie, Pa.
D. D. McKinney, Hammermill Paper Co., Erie, Pa.
J. H. Groves, Union Bag & Paper Corp., Savannah, Ga.
Geo. Arthur, Champion Paper & Fibre Co., Canton, N. C.
L. M. Lenzi, The Mead Corp., Chillicothe, Ohio

J. H. Groves, *Chairman*

Papermaking Cylinder Committee

The Papermaking (Cylinder) Committee meeting was held on Monday afternoon, Feb. 16, 1953.

The meeting was called to order by James J. Harrison, chairman of the committee. Mr. Harrison tendered his resignation as committee chairman, and Glen Renegar of Container Corp. of America was selected as the chairman for the year 1953. Dr. Harrison agreed to act as assistant chairman and help in any way possible to further the interests of this committee.

The next order of business was to appoint subcommittees to work on the various areas of interest to this group. The following subcommittees were set up and chairmen appointed:

Raw Materials—A. E. Bachmann, Missisquoi Corp.
Stock Preparation—E. F. Manogue, Gibraltar Corrugated Paper Co.
Odor Problems—J. L. Loomer, Robert Gair Co.
Wet End Operation—S. W. Smith, New Haven Pulp and Paper Co., G. C. Ehemann, Ohio Boxboard Co.
Drying and Finishing—Ken Winrich and L. S. Johnson, Cornell Wood Products
Caliper and Weight Control—Lew Ayres, Robert Gair Co.
End Use Requirements and Testing—A. T. Luey, Sutherland Paper Co.

Following the discussions of the subcommittees and their work, a general discussion was held and it was decided to have a general discussion of papermaking problems on Wednesday afternoon.

One scheduled meeting of the Papermaking (Cylinder) Committee was held on Tuesday afternoon. There were

three papers presented at this session which were all very good and well received.

It was proposed that a small meeting of the Papermaking Cylinder Committee be held this Fall at some central location to determine the progress of the various committees, and also, have discussion meetings. The consensus was that this meeting should be held in September or October at a time which did not interfere with other Fall meetings. This meeting would be a one or two-day session if it could be worked out.

JAMES J. HARRISON, *Chairman*

RECENT BOOKS

Starch. By Charles A. Brautlecht, Professor Emeritus, University of Maine. Reinhold Publishing Co., New York, 1953. Cloth, 6 × 9, 408 pages. $10.

Dr. Brautlecht, formerly head of the Chemistry Dept. of the University of Maine, is well known to the paper industry. His interest in the economy of Maine's potato crop is also known. In the problem of overproduction he made considerable effort to develop chemurgic products from potatoes.

The present volume covers the entire field of starch but gives more consideration than any book thus far published to the starch products from various kinds of potatoes.

Written for the general reader the book, which is well documented, covers the production and uses of starches from potatoes, corn, wheat, tapioca, rice, and arrowroot. Consideration is given to special forms and modified starches, dextrin, glucose, and caramel. Physical characteristics of starches are revised and methods of analysis given.

Forest Policy. By William B. Greeley, Vice-President of the West Coast Lumbermen's Association. McGraw-Hill Book Co., New York, 1953. Cloth, 6 × 9, 278 pages. $5.50.

"Forest Policy" is a book in McGraw-Hill's American Forestry Series and deals with the controversial subject of forests as they relate to the public. The author reviews the prevailing forest policies of Germany, France, Switzerland, Russia, Japan, Scandinavian countries, Great Britain, Canada, and South America. These reviews are followed by consideration with an interpretation of American policy, including state policies, research, taxation, flood control, forestry aids, and the national wood supply.

Ion Exchanges in Analytical Chemistry. By Olof Samuelson, Professor of Engineering and Chemistry, Chalmers Institute of Technology, Gothenborg, Sweden. John Wiley & Sons, Inc., New York, 1953. Cloth, 6 × 9, 291 pages. $6.50.

The author, Dr. Samuelson, is a world authority on the subject of ion exchangers. Since 1939 he has published many articles on the subject in Swedish.

His coverage of the subject includes first, the general aspects of the subject such as the properties of ion-exchange resins and ion-exchange equilibria and kinetics. Second, he covers the practical techniques of ion-exchange and third, he covers the field of application and its problems.

One chapter is devoted to sulphite spent liquor. In this chapter he features the application of cation exchangers, anion exchangers of the weakly basic and strongly basic types. In addition to a bibliography he presents the method of determination of thiosulphate and polythionate.

The Intelligent Use of the Microscope. By C. W. Olliver. Chemical Publishing Co., New York, 1953. Cloth, $5^1/_2 \times 8^1/_2$, 192 pages. $4.00.

The author has written a book for the student and beginners. It shows the microscope as an optical instrument with several degrees of efficiency, the lower efficiency being sufficient for routine work and many forms of research. Relative theory is presented. Since this volume is the second European edition he has brought his original thesis up to date by including an account of phase contrast microscopy which has done away with some of the most awkward limitations of the microscope.

Among the subjects covered are equipment selection, use, measurements and counts, filters, photomicrography, and special instruments.

The reviewer has often wondered why there were so few experts in microscopy in the paper industry. It appears to be a useful tool, not only for laboratory technicians, but for salesmen, engineers, and executives.

Note: Books mentioned in this column may be obtained from the Book Department of the Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York 17, N. Y.

EMPLOYMENT SERVICE

POSITIONS OPEN

P294-53. Paper Chemist for important supervisory work in large research laboratory. Prefer Ph.D. with paper industry experience and good chemical background. Please send details of education and experience.

P306-53. Paper Chemist. At least two years' experience in paper manufacturing and coating for work in development and application of chemicals and paper coating. Fine opportunity with established chemical firm in large eastern city.

P307-53. Chemical Engineer or graduate of a pulp and paper school with several years' experience in the industry, preferably in coating or tub sizing, desired by Midwestern supplier.

P308-53. Chemist with training or experience in the pulp or cellulose field, desired by research laboratory.

POSITIONS WANTED

E233-53. Plant Engineer with 6 years' experience in a paperboard mill desires position in the South or other location where climate is moderate. Experience includes equipment design, layout, installation, and maintenance.

E234-53. Chemist with several years' experience in a paperboard mill and converting plant. Varied experience in quality control, research, and production. Desires comparable position in progressive company.

E235-53. Sales Engineer with B.S.Ch.E. degree. Age 35. Experienced in pulp and paper mill operation as well as general industry selling. Desires to represent one additional company in Alabama and adjacent area.

E236-53. Paper Chemist. M.S. Chemical Engineering; B.S. Pulp and Paper. 28, married, three years' industrial experience in filter paper and media research and development, resin application, and quality control. Some supervisory experience. Research position desired.

E237-53. Swedish Chemical Engineer with equivalent of Master's degree and six years' experience in pulp and paper research, particularly semichemical pulping, desires position, preferably in the New England area or on the West Coast. Publications.

Note: Responses to Positions Wanted and Positions Open should be sent to the Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York 17, N. Y.

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Lake States

The fifth Lake States Section TAPPI meeting of the current season included a well-organized tour of the Nekoosa mill of the Nekoosa-Edwards Paper Co. the afternoon of April 15, 1953, followed by a panel discussion, dinner, and after-dinner address at the Elks Club in Wisconsin Rapids, Wis.

Two hundred fifty Section members visited the Nekoosa-Edwards Paper Co. Mill, Nekoosa, Wis., to see the progress on their impressive modernization program, spotlighting their new Pusey and Jones paper machine that was put into operation in January of this year. This new installation has received a great deal of publicity in the trade journals (*Paper Mill News* 76, No. 9 (Feb. 28, 1953)), and the Lake States TAPPI members were convinced that it is all that has been claimed for it and more.

There was standing room only in the Elks Lodge Room for the panel discussion on "Wet End Operating Conditions and Paper Qualities" with B. L. Kassing, Nepco Director of Process and Product Development, as moderator. The discussions covered the following wide range of paper grades with 15 min. allotted to each:

Rag bonds, L. A. Moss, Whiting-Plover Paper Co.
Coating base-papers, W. J. Foote, Consolidated Water Power & Paper Co.
Kraft papers, R. D. Rusch, Mosinee Paper Co.
Sulphite papers, L. Sabatke, Marathon Corp.
Glassine, L. Parkinson, Rhinelander Paper Co.

These discussions emphasized the special properties desired, problems encountered, and unusual operating conditions required for each grade. Similarities and contrasts were noted. After the formal discussions, the meeting was thrown open by Mr. Kassing and the audience took active part in a lively question-and-answer session.

Finally Mr. Kassing briefly summarized the areas of general agreement on operating conditions and also features on which there was a marked difference of opinion.

An interesting and informative after-dinner speech on the subject, "Economic and Engineering Problems Involved in Building New Mills," was delivered by Harold G. Ingraham of Chas. T. Main, Inc.

Wet End Operating Conditions and Paper Qualities—Rag Bond

L. A. Moss

WE FEEL that we have some of the answers for better operation in the manufacture of rag papers and we are gradually learning others. At one time I did a thesis entitled, "A Photographic Study of the Motion of Fibers and Water in Flowing Fiber Suspensions." In this work high-speed photography was used to actually show the movement of individual fibers through models of various types of flow boxes and inlets. This did show fundamentals which help to understand some of the phenomena of practical papermaking, but in actual operation we must still depend heavily upon experience gained by trial and error.

Papermakers have never been quite satisfied with their stock delivery to the wire and have exercised their ingenuity to the utmost to attain more nearly perfect performance. The perfect headbox and inlet still have not been designed and I do not feel I am being unduly pessimistic when I predict there will never be a perfect design.

In bond paper we are after two relatively smooth, hard, well-sized surfaces, properly receptive to printing, typing, or pen and ink. These two surfaces should be as nearly identical as possible and be separated (or held together) by an interwoven structure of fibers giving strength, stiffness, opacity, bulk, etc. Wet end conditions vitally affect each and every one of these sheet properties, and the best stock preparation is of no avail unless the stock is properly handled on the wet end to fully develop its potentialities.

Of course you all know the primary function of the headbox assembly. It receives the stock from the screen and spreads or distributes it for smooth and uniform delivery over the full width of the fourdrinier, at or near wire speed, and ordinarily traveling approximately parallel to the wire movement. At the same time the headbox is spreading the stock flow to wire width, it must also provide agitation to keep each individual fiber and particle of furnish separate from all other particles to allow easy interweaving of fibers during sheet formation.

Compared to most other grades of paper today, rag bond papers are made at slow operating speeds. This fact simplifies the problem of formation in some ways, but in other ways it creates problems. The relatively slow flow rate of stock through the headbox requires careful handling to insure proper mixing and to prevent dead pockets. Most rag mills, including Whiting-Plover, have tried to use the perforated distributor roll to give even flow and good mixing, but in virtually all cases, the distributor roll causes lumps in high rag content stocks where fibers are long and slow, the consistency is relatively high, and the rate of stock flow is low. Under these conditions soft lumps form on the edges of the holes in the roll, and the perforated roll does not give enough agitation at the slow flow rate to completely break up such soft lumps before the stock flows out on the wire. Since we must make everything from light onion skin to heavy ledger and from 100% rag to 100% wood pulp all on the same machine, we

Seated: W. J. Foote, Consolidated Water Power & Paper Co.; L. Sabatke, Marathon Corp.; and R. D. Rusch, Mosinee Paper Mills Co. Standing: L. Parkinson, Rhinelander Paper Co.; B. L. Kassing, Nekoosa-Edwards Paper Co.; and L. A. Moss, Whiting-Plover Paper Co.

L. A. Moss, Mill Manager, Whiting-Plover Paper Co., Stevens Point, Wis.

cannot use any device which will not function over the whole range. Hence the distributor roll is out.

As a result of this situation we have to depend heavily on the agitation and mixing action obtained between two slices to break up flocculation and give even distribution of stock across the machine. This double slice principle is very old, but it is still without equal for slower operating machines.

The consistencies used for long, slow stock at low speeds are relatively high, ranging from 0.4 to 0.8%. Thus, thorough agitation and mixing are all the more necessary and at the same time more difficult. These same conditions retard escape of air from the stock and trouble is encountered with air bubbles being retained in the stock during formation to cause thin spots in the final sheet.

The head of stock in the pond back of the slice, of course determines the velocity of the stock stream flowing from the slice. By proper adjustment of this head the proper stock velocity relative to the wire speed must be attained. I seems to be generally agreed that a stock velocity slightly greater than wire speed is desirable to get increased fiber alignment across the machine—thus supplementing the effect of the shake. This is quite generally true for bond grades of paper, whereas for certain other grades, such as twisting papers and crepe papers, strong alignment of fibers in the machine direction is obtained by having the stock stream delivered slower than wire velocity.

The height of the slice opening actually determines the velocity of stock delivery because the stock will back up behind the slice until sufficient head has built up to force the full flow of stock through the slice opening. In order to get even weight and caliper across the machine it is necessary to have the slice opening even across the machine, and variations in weight and caliper can be corrected by proper adjustment of this slice opening. In a two-slice inlet arrangement the adjustment of the second slice largely determines sheet weight and caliper across the machine, but it also is necessary to have the first slice adjusted evenly to prevent cross currents in the pond between the slices which can cause uneven formation, uneven shrinkage on drying, and attendant troubles.

The pond head behind the first slice determines the velocity of stock delivery, but the height of this pond relative to that of the pond between the slices determines the stock velocity entering this pond, and this velocity in turn determines the amount of agitation for vitally important final thorough mixing and breakup of flocculation before delivery to the wire from the second slice.

The position of the apron with respect to the slices may be varied widely. The most common practice seems to be to have the apron end approximately under the first slice so that drainage begins at this first slice. We have also operated with the apron extending up even with the second slice, and at another time with the apron extending as much as 8 in. down the wire beyond the second slice. With suitable adjustment of pond head, slices, water, etc., satisfactory sheet formation can be obtained with any of these arrangements.

The shake is another most important factor in sheet closure and formation. It is only necessary to shut off the shake on a machine a few minutes to see how much freer the stock acts as evidence that the shake does things to the fibers as they knit together on the wire. The shake movement causes the fibers to interweave more intimately for compactness and increased strength in the sheet. The side-to-side shake of the surface on which the fibers are being laid down tends to break up the machine direction alignment caused by stock acceleration in passage under the slice, and gives greater cross-machine strength.

Generally speaking the shake stroke should be longer for long-fibered stock and shorter for short-fibered stock. The shake speed determines roughly the degree of effect obtained; but when a very long stroke is used, the speed of shake will be limited by what the shake mechanism and fourdrinier can stand. We usually run about 200 to 250 strokes per min. and the stroke amplitude varies from $^1/_4$ to $^3/_8$ in.

The dandy roll puts the finishing touches on the sheet formation, pressing down and compacting the interwoven mat of fiber formed up to that point. There is no doubt but that it also causes a considerable degree of slippage of fibers over each other to allow a marked leveling effect on the sheet. To accomplish this it is naturally necessary to adjust the water removal up to that point, so that just exactly the right amount of water remains to allow the dandy to do its job. If the sheet is too wet, crushing results, and if it is too dry, the desired leveling is not obtained.

Vacuum alone, whether applied at boxes or at the couch, seems to do much less compacting of the sheet than does the pressing action of the dandy roll or a lump breaker roll. Extensive use of vacuum is necessary to accelerate dewatering for faster operating speeds, but actually this use of strong vacuum is harmful in that it tends to increase two-sidedness by pulling filler, fines, and sizing material from the bottom of the sheet. In this respect it is certainly a very necessary evil.

In the press section the sheet is further compacted to increase strength, but bulk and opacity are somewhat decreased. We find that we usually pick up some embossing effect from the second press on the felt side of the sheet, particularly if the second felt is worn nearly to the end of its useful life. The use of the smoothing press ahead of the drier section eliminates this impression almost completely, but if the smoothing press is skipped the impression can show up plainly in the finished paper.

Wet End Operating Conditions and Paper Qualities—Coating Base

W. J. Foote

The following remarks will be restricted to the manufacture of base stock for machine-coated book paper although in practically all respects they would also hold true for base stock for off-machine coating. In addition, use requirements will be considered principally in terms of roll stock since the largest proportion of machine-coated paper is printed on rotary presses.

The principal requirements of the printer-customer might be listed as: (1) undamaged delivery of the paper, (2) good mechanical performance in the pressroom, and (3) satisfactory printing quality.

Characteristics of the paper which are necessary to satisfy the first two items include uniform rolls, evenly wound, with no hard or soft ends or areas, and no ridges or corrugations. The paper must be as free as possible of slime and other holes, cuts (hair, fiber, or calender), poor splices, cracked edges, rough edges or turnovers, scrap in roll, loose coating or coating scale, and foreign material in paper or on paper or on edge of roll (e.g., glue, oil, slitter dust). The paper must have sufficient strength to pass through the press and subsequent converting operations without failure.

Characteristics of the finished paper which would affect printability would include:

1. Surface smoothness, initial and under impression. This involves compressibility, resiliency, and uniform thickness.
2. Ink receptivity. This involves surface wettability and paper permeability to ink, both initially and ultimately.
3. Surface resistance to picking, fluffing, or dusting. Depending upon the printing process used, this resistance may have to be at normal moisture content or when surface is moistened.
4. Optical characteristics and appearance. This would involve color, brightness, opacity, gloss and general cleanliness.
5. Body strength and dimensional stability to resist the tensions and distortions introduced by the mechanics of printing.

W. J. Foote, Manager of Wisconsin River Mill, Consolidated Water Power & Paper Co., Stevens Point, Wis.

6. Chemical reactivity, pH, and moisture content.
7. Formation.

In all of the above qualities, the most important factor is uniformity from sheet to sheet, roll to roll, or lot to lot, and needless to say, from side to side. The internal characteristics of the paper are not of particular interest to the printer other than in their effect on surface characteristics and mechanical performance

Now, as to the coating raw stock required to produce the above-listed qualities in the finished paper.

The base sheet must be free of the same defects which are objectionable in the finished paper.

Any nonuniformity of the raw stock will necessitate compensating action in subsequent coating and finishing operations, often with bad effects on the final printing quality. For example, lumpy formation will result in the supercalendered paper having spots with varying densities which will result in nonuniform ink receptivity.

The most important qualities of the coating raw stock might be condensed to: (1) adequate strength; (2) no mechanical imperfections; (3) uniform basis weight, caliper, and moisture content; (4) uniform wettability; (5) uniform density; (6) uniform formation; and (7) uniformly smooth surface.

The lay of fibers on the surface must be such that they do not penetrate the layer of coating. Wild formation and fuzz cannot be covered up by the coating. As a matter of fact, in many coaters, any nonsmoothness of the raw stock is exaggerated by the coating layer.

As can readily be seen, many of the qualities listed so far are not affected by wet end operation. The wet end operation might well be interpreted in terms of its effect on formation, sheet density, internal and surface characteristics of the sheet, and the uniformity of all these. Uniform formation will result in uniformity of practically all qualities unless there is distortion or rupture of the sheet subsequent to formation.

To follow the flow of the relatively free book-paper stock from the screens to the drier section:

HEADBOX-SLICE CONDITIONS

Mechanical Condition

The conventional headbox must be so constructed that all interior surfaces are smooth and rounded, allowing no dead spots to occur. The construction of the slice must be substantial enough not to deflect under the hydraulic pressures required.

Discharge from the screens to the headbox must minimize spouting or cascading. Streams of relatively high velocity stock may carry all the way through the slice resulting in streaks of uneven weight and caliper. Air entrapped by cascading introduces foam, tends to increase aggregation of fibers into clots and stringers, and accelerates slime formation.

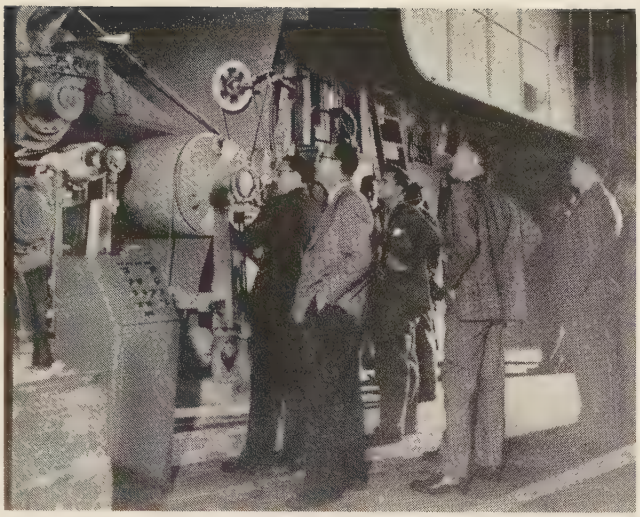
Headbox Consistency

Control of headbox consistency is dependent upon the nature and preparation of the stock furnish, the basis weight required, temperature and drainage rate of the stock, machine speed, and forming ability (a combination of wire length, mesh and weave, and dewatering capacity of the fourdrinier). As a generalization, it might be said that good formation requires sufficient water to separate the fibers and thus eliminate flocculation—the more the better until you approach the point where the sheet washes around on the wire causing streaks. There certainly should be enough water to carry the sheet wet down to the dandy roll. Too high a consistency retards levveling and tends to produce fiber clots, thin edges, and stock which can shake into a mottled, galvanized effect.

Slice Head and Velocity

The slice must deliver a uniform flow with both equal volume and equal velocity across the wire. We believe that stock velocity should be very close to the wire speed. Too high a head will result in forward waves causing cross-grain streaks of light and heavy stock. Too low a head will result in drawing the fibers out into orientation along the machine direction. This may or may not be a bad thing.

A compromise has to be made between streamlining the flow to get uniform weight and caliper across the sheet and gentle agitation to eliminate fiber clumps.



Inspection of the new NEPCO machine during the mill visit

Slice Lip and Apron Location

We customarily have both the lip and apron edge very close to the center line of the breast roll, the slice lip possibly being a small fraction of an inch downstream. If the lip is too far downstream, it may cause lumps. The mechanical condition of the slice lip and apron are of considerable importance and if either is dirty or not smooth, it can introduce streaks and lumps.

FOURDRINIER OPERATION

Effect of Shake

The effect depends upon the speed of the wire and the drainage rate of the stock. There is not much effect on fast machines with marked pitch to the wire. Recent work in England and Sweden indicates that shake disperses fiber clumps but that degree of fiber orientation is due to the relative speeds between stock at the slice and the wire. Furthermore, they have evidence supporting the belief that anisotropy is not necessarily a result of fiber orientation but due more to the stresses and strains introduced during wet pressing and drying.

As a matter of fact in coated book paper for rotary press operation, the "square" sheet might not be the best since the physical demands on the paper are essentially for high machine direction tensile strength and high cross-direction tear.

Factors Between Slice and Dandy Roll

Goodwillie states: "the greatest formation hazard comes while the sheet is on the first few feet of the wire." It is very fluid and rapid drainage tends to flood table rolls causing more or less violent disturbance of the forming sheet. Combinations of forming boards and deflectors have proved effective in removing most of the flooding water. Dandy-type table rolls and grooved rolls have been used successfully. Many paper defects can be caused by table rolls being out-of-round, jumping, or stopped. Number and diameter of table rolls should be adjusted to machine speed and stock conditions. The mesh and weave of the wire will have definite effects on the surface of the sheet.

Influence of Dandy Roll

Essentially, the dandy roll acts as a lump breaker, does a slight amount of compacting of the sheet, and possibly levels

out moisture content, thus making the operation of the suction boxes more uniform. Possible defects introduced by the dandy roll are picks, lumps, or crushes caused by a dirty cover, damaged or loose cover, too much shower water, or the paper being too wet or too dry to the dandy roll.

Influence of Vacuum

For mechanical and cost reasons, it is preferable to use as little vacuum as possible. The ill-effects of using too much vacuum, quality-wise, would be to accentuate two-sidedness, particularly in a filled sheet. Probably the most important thing is to have evenness across the sheet. This is not too easy to accomplish on many paper machines. The vacuum boxes remove water, harden and compact the sheet.

PRESS OPERATION

The press section removes water, compacts the sheet, can improve bursting strength slightly, and imparts some degree of finish to the paper. Actually, operation of the press section cannot do much to improve the quality of the sheet. It is more an effort to remove water without damaging the sheet. There are not too much data available on the effects on quality of felt tension and nip pressures. Both are important factors in water removal and felt life. Excess sheet tension, due to tight draws, may result in curl of the finished paper. Finish is not too important a factor in coating raw stock. Several closely associated characteristics, surface smoothness and sheet density, are very important. Their importance lies in the fact that any nonuniformity in these will have a serious effect on the uniform application of coating to the sheet.

The defects which must be avoided in the press section include: (1) crush marks; (a) general (too much pressure for sheet moisture content) and (b) local (felt plugged or seam crooked); (2) blanket marks—felt nap worn away; (3) shell marks (excess vacuum with light or thin felt); (4) blow marks; (5) water, oil, or acid spots or streaks; (6) streaks or marks from leaky doctor or press roll surface condition; (7) marks due to too tight a draw; (8) wet or dry streaks due to wrong crown for weights applied; (9) fuzz or crumbs due to top roll picking surface of sheet; and (10) reduction of sheet strength due to distortion or rupture by excessive pressures.

Noel Phillips says: "If ideal formation could be rated as 100%, 50% of the ideal would be dependent upon proper stock preparation and 50% on proper manipulation of the fourdrinier." This is rather a challenging statement. So much depends upon how close you are operating to the optimum possible with the equipment available. If you are within a reasonable distance of getting the most out of your wet end, formation is probably due 90% to stock and 10% to the fourdrinier and you are safe in saying "paper is made in the beater." Should you not be operating most efficiently, the percentages might well be reversed and "papermaking is an art." The whole thing probably boils down to the fact that you cannot make better paper than the furnish you start with but you can ruin a good furnish by improper manipulation of the fourdrinier.

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Wet End Operating Conditions and Paper Qualities—Sulphite Papers

Lawrence Sabatke

I HAVE been asked to discuss some of the wet end operating conditions and qualities that we at Rothschild desire in our sulphite and food papers. We have one board machine, two straight fourdriniers, and one combination fourdrinier-Yankeee. My remarks will be confined to the wet end of the fourdrinier.

In the manufacture of food papers we use all kinds of furnishes from 100% kraft and 100% sulphite to combinations of both, and various combinations of sulphite, kraft, soda, hardwood sulphite, and in some cases, groundwood. Our basis weights vary from 16 to 240 lb. on a 24 × 36—500 basis. We vary the basis weight on one machine from 20 to 240 lb., with a variation in finish from no calendering to nine nips, to water finish and dry finish using two calender stacks with 13 nips.

Some of the remarks that I will make in this discussion may be regarded as highly controversial and may even border on being fallacious. They may or many not be false in my opinion but I hope that you will keep them in mind so that we can get an open discussion of them. Also, I may from time to time mention some particular equipment by its manufacturer's name, not because I believe that it is the best equipment but merely because it is what we are using and with which we at Rothschild have the most experience. They happen to be the tools with which we have to work. I believe that there isn't anything made, regardless of how good, that someone else isn't making just as good or even a little better, or can if he wants to.

Every sheet that we make has a complete set of specifications dealing with the end use for which it is designed. In food papers we always want the maximum burst and tear with the cheapest possible furnish which, in our case, is sulphite. Consequently, not only to us but to all papermakers the pulp must be right. We, at least, have found it impossible to make something out of nothing. Let us assume that our furnish is satisfactory, that is, good pulp, clean, properly refined, screened, cleaned by any of a number of various types of equipment, pH is right, water, etc., and it enters the headbox in proper condition.

The function of the headbox is to distribute the stock uniformly over the entire width and to disperse it, delivering it to the slice without any whirlpools, streaks, channeling, etc. Must a headbox have baffles, partitions, distributor rolls, and how many; a division in velocity and head?

We have two types of headboxes—one is a Bertrams flow distributor made of stainless steel with one distributor roll. The other is made of wood with three divisions and one distributor roll. Both are doing a good job of delivering the stock to the inlet, which, as I have mentioned before, is what we expect of our headboxes.

We believe the next foot or so is the most important part of the paper machine—the inlet or slice and apron board. The slice must be flexible enough to be able to level off the sheet. We use a Voith slice and are able to control our basis weight to a variation of $^1/_2$ to 1 lb. across the width in a 6 by $15^7/_8$,

LAWRENCE SABATKE, Paper Mill Superintendent, Rothschild Mill, Marathon Corp., Rothschild, Wis.

or 95 1-sq. in. sample with either headbox, the length being in the machine direction.

How many of you still use rubber aprons? How many use a combination of metal and rubber aprons?

The pitch of the metal apron is quite important as well as the distance of the fall from the end of the apron to the wire. The position of the apron to the center of the breast roll is also important. In making a wide range of basis weight papers one should have at least a movable apron. We would prefer a movable apron and slice.

What type of tube roll is the best—brass, fin-type, micarta, rubber covered, dandy-type, etc.? What diameters should the tube rolls be? How close should they be? Will tube rolls cause a curl in the finished sheet? We have found that it is necessary, depending on the type of sheet, to raise or lower some tube rolls depending on the water removal we require for the type of sheet being made.

What type of suction box covers and type of holes or slots is another controversial question. We like the drilled box and believe that how the cover is dressed is very important. We use an Eastwood Neally Corp. suction box cover conditioner for dressing our boxes and are very particular to see that the boxes are installed correctly on the machine, that is, level with and at right angles to the wire.

Is there anybody here that has had any experience in wire life with oscillating boxes versus stationary boxes? We still have the stationary suction boxes.

In the operation of the fourdrinier I believe the shake is very necessary for the range of our speeds. Our machine speeds vary from 90 to 800 f.p.m. I have heard it said that for machine speeds of over 1000 f.p.m. the value of a shake is practically nil. However, I do not believe that the speed of the shake is proportional to the speed of the machine. In other words, if you are running a machine satisfactorily at a speed of 300 f.p.m. with a shake of 300 strokes per min. it does not mean that at a machine speed of 600 f.p.m. that you would have to run the shake at 600 strokes per min. We find it necessary to vary the number of strokes per minute and the length of the stroke, but the changing of the number of strokes or length of stroke is not a "cure-all."

We have found the trunnion-type dandy a big improvement over the old-fashioned small heavy type. A dandy improves the formation but it can at times by a headache on heavy-weight board for printing and titanium-filled sheets for waxing grades.

On lightweight papers the amount of vacuum on the suction couch is very important for good operating conditions.

How about "worms?" What do you do to correct them—the use of different type-tube rolls, forming board, deflectors between tube rolls, slice, apron, or what?

The physical characteristics of a sheet can be changed somewhat by lowering or raising the head in the headbox, stroke, and speed of the shake, rushing of the stock on the wire, etc.

Here is an example of a papermaker's nightmare. We now have the sheet coming over the wire but it is full of bubbles. There is some foam in the headbox but not too much. You try various types of foam killers, steam showers, water showers, check your pumps, but nothing seems to help. You watch the sheet forming on the wire but you can't see the bubbles until you get up on the footboard and look down on the sheet and there they are. What to do next? What would you do? Will a Deculator help in this case? I don't know but would like the answer. How about the pulp?

Going to the press section with a suction-first press the type and condition of the felt is perhaps the most important in controlling "shadow marking." How tight the draws are between press sections will influence the physical tests like burst, tear, and tensile. Also a rider roll on the couch will help with some physical tests, primarily porosity and density.

Wet End Operating Conditions and Paper Qualities in a Kraft Mill

R. D. Rusch

Present-day uses and users have demanded that kraft papers be almost as uniformly formed as book papers and still pass such tests as point per pound burst, 100% machine direction tensile, 50% cross-direction tensile along with a high tear. In order to accomplish these goals a kraft papermaker must use relatively low consistencies at the wet end and keep his fibers completely dispersed until the last wet vacuum box is passed.

The kraft industry uses all three general types of headboxes; the open box, straight pressure, and the air padded or vacuum. These headboxes can be equipped with various types of slices. The relative merits of each type are certainly a controversial question. Perhaps the perfect slice will be a combination of both curved and straight slices. After visiting mills from coast to coast and from the South through Canada, one can say that either there are several ways to accomplish the same thing or local conditions are, to quote the late Dr. Kahlenberg, professor of chemistry at the University of Wisconsin, "highly specific."

In general, consistencies in the kraft industry are relatively lower and fan pumps must be larger for a given width machine (0.20 to 0.60%). The level of the collector box sets the pressure on the stream flow valve. Opening of the stream-flow valve determines the rate to the wire. The slice opening will be greater and on most sheets the velocity will be less than theoretical, that is, the sheet will be "dragged" a little.

Most slice lips are located directly above the center line of the breast roll or a little forward of this point. The slice apron is located at any of the three possible positions below the lip depending upon local success with pressure formation.

In general, longer aprons seem to improve the formation of heavy weights.

In laying a kraft sheet on the wire, a formation board in place of the first tube roll seems to afford the distinct advantage of taking the "jump" out of the stock on the wire.

With the advent of higher speeds and wider machines, the old controversy between large and small diameter tube rolls has of necessity disappeared. Efficient deflectors are necessary and their shape and position seem to be a question of trial and error. For a local condition, we have found that they work best when not too wide on top and $\frac{1}{8}$ in. below the wire. From the holder they slope at a 45° angle toward the contact point of the preceding tube roll and in such a manner deflect the throw-off of this tube roll and prevent it from disrupting the sheet already formed.

We have installed a shake on our latest rebuilt machine. Up to the present, we have found that it has not improved the formation of our sheet at speeds above 700 f.p.m.

Dandies do definitely improve the formation of kraft papers but we have found that modern larger diameter heavy dandies do not work as well as relatively lightweight dandies no matter where they are located.

In handling sheets on the wire that carry as much water as kraft papers, it is highly important that as low as possible vacuum be carried on the flat boxes and that they be carefully graduated.

The width of the vacuum box in couch is definitely dependent upon the heaviest weight run. The heavier the weight, the greater the time element necessary for the prevention of "skips" even at maximum vacuum. A two-box vacuum couch is very practical for a kraft specialty mill. A two-sided sheet is not objectionable for twisting tissue.

Perhaps the "lumpbreaker" roll has been the greatest boon to the safe high-speed operation of kraft paper machines in modern times. With its use, the per cent moisture of the sheet leaving the couch is definitely lower and therefore the

R. D. Rusch, Paper Mill Superintendent, Mosinee Paper Co., Mosinee, Wis.

wet web is appreciably stronger and much less apt to break. This observation has been proved statistically by over 2 years' operation.

A vacuum press section is a must in the kraft specialty paper manufacture; first because it permits the use of higher pressures when high density papers are being produced and it makes possible the removal of more water at lower press pressures when high bulk papers are desired. These effects are emphasized by the new upside-down second press.

The ideal hardness of the rolls in a press section is a good question for debate. From experience, may it be offered that the softer the better and the larger the diameter, the more water that can be removed without crushing.

Wet End Operating Conditions and Paper Qualities—Glassine and Greaseproof

Leonard Parkinson

Papermakers used to say that paper was made in the beaters. Stock preparation is still a very important step in papermaking—we may or may not have beaters, but in view of increasing machine speeds and the trend toward producing a sheet specifically made for a known end use, the paper machine wet end has become more and more important.

The present wet end is not adapted to the wide variation of grades formerly produced and is dependent to a great extent on the skill of the papermaker. Rather the skill is now in the hands of the designer, a combination of engineer and papermaker. Knowing what a machine is expected to produce they design a wet end incorporating all their knowledge and experience.

We, at Rhinelander, are the largest producers in the world of glassine and greaseproof papers. As papermakers our primary concern is handling stocks of extreme slowness.

The wet end conditions best suited for this type of stock are, in general, well known and can be listed somewhat as follows:

Headbox conditions:

1. Usually heated stock of minimum dilution.
2. Low head.
3. Low slice.

Fourdrinier operation:

1. Long wire.
2. Slow speed of wire.
3. Minimum drainage at breast roll.
4. Vigorous shake.
5. Many table rolls, closely spaced.
6. Many flat boxes.
7. Large couch with maximum vacuum area.

Press Operation:

1. Usually three to five presses.
2. Minimum loading to avoid crushing.
3. Importance of reverse press on density.

I have been asked to speak in some detail on the relationship of the wet end conditions and the resulting quality of our particular papers—glassine and greaseproof.

The function of the headbox and slice is to deposit an even, smooth layer of stock on the moving fourdrinier wire. The stock layer must be uniform in thickness across the wire and the velocity of the stock leaving the slice must be approximately equal to the speed of the wire.

Stock of extreme slowness tends to floc very rapidly and will form lumps at the least opportunity. Consequently we prefer a headbox of minimum holding time, and as free as possible of gadgets such as flow eveners and restricting devices.

Our headboxes are constructed of stainless metal, open, of simple four-compartment design. All edges are well rounded, we use an adjustable baffle in the second and fourth compartments. Two rectifier or "holly rolls" are used, these are rubber covered, inset heads, outside bearings; one in the second compartment and one immediately before the slice.

All moving parts must have ample clearance to allow for the expansion resulting from our hot stock, and pond sprays should be of hot water—the channeling effect of cold water on hot stock being well known.

My observations have led me to believe that all headboxes and slices have fixed, inherent faults which result in flow shifts across the web, as well as pulsating or surge changes which effect weight in a longitudinal direction. There should be some way to shift baffles in our rectifier rolls to counteract these faults.

Our headbox consistency ranges between 0.50 and 0.55%, and we use the Valley or Voith slice. The bottom apron is of metal and extends to the center of the breast roll. The top lip can be moved forward or backward but we prefer a position about $^3/_4$ in. behind the tip of the bottom apron. The angle of the top lip is very slight so that the stock is released parallel to the wire, a condition which is optimum in the Van de Carr slice as contrasted to the usual steep angle of the Valley slice where the stock is driven into the wire.

The opening or orifice, formed by the top and bottom lip is about $^5/_{16}$ in.; we use a wedge to reset this periodically. Adjusting screws on the top lip are spaced on 6-in. centers. It is our custom to weigh 4 by 4-in. sheets across the web as levelness and uniform caliper are extremely important in glassine papers.

Strangely enough, supercalendering appears to aggravate differences in bulk across the web and ridgy rolls will result from very slight variations. Thus we tend to judge a machine tender's ability by his knowledge of "slice" adjustment.

On high-speed machines and free stocks the fourdrinier part has become simply a means of removing water. When the sheet is set some 3 to 4 ft. from the slice there is nothing that can be done in the manipulation of the table to alter the formation pattern laid down by the inlet.

On our grades the other extreme prevails; little water is released at the breast roll and the fourdrinier section can be altered to secure the best results in formation and density of the sheet.

On some types of papers the industry has come to question the merit of the shake as an aid to formation. Recent experience has proved to me that proper manipulation of the shake is essential on slow stock where sufficient water remains to keep the greater proportion of the fibrous mat in a fluid condition.

Until recent times the fourdrinier rails were built in one piece, the shake being at a maximum at the breast roll and diminishing in the zone prior to the flat boxes. Thus the shake was at its maximum stroke where the preformed portion of the sheet carried its greatest head of water. This method of operation is wrong. By the violent disturbance of this liquid zone a washing action occurs which affects the levelness and uniformity of the fibrous mat already beginning to form. On slow stock the maximum shake should be applied some distance down in the forming area. Of necessity this method of operation requires split or sectional rails.

Our table rolls are $6^1/_2$ in. in diameter, rubber covered, and closely spaced. On our big machines we carry 11 flat boxes—the vacuum being graduated from $1^1/_2$ in. in the first box to $3^1/_2$ in. in the last. It is possible to pull pinholes in the sheet by too much vacuum on the flat boxes.

The couch roll is a safe place to apply all the vacuum possible. On our 42-in. couch rolls we have a vacuum area of 24 in. and usually carry some 23 to 25 in. of vacuum, originating in two L10 Nash pumps.

On most grades of glassine the sheet is couched from the wire at 14 to 17% air dry.

As manufacturers of both glassine and greaseproof papers we are at cross purposes on our presses.

Leonard Parkinson, Rhinelander Paper Co., Rhinelander, Wis.

For greaseproof papers maximum wet pressing is essential to compact the sheet and secure the extreme density typical of this paper. On the other hand, the loss of bulk by so much wet pressing has an adverse effect on glassine. Papers to be supercalendered, such as glassine, are best with a certain bulkiness; it gives the supering rolls something to bite on and improves transparency.

We cannot load our first press, in fact the top roll is of special lightweight construction. Usually we carry a light loading of the second press and then stepwise to maximum loading at the reverse press (26 to 28% air dry going into driers).

Our business of protective papers is built on the ability to produce a continuous film or barrier. Any attempt to remove water rapidly will result in distortions which defeat this purpose.

Wet End Operating Conditions and Paper Qualities—Summary

B. L. Kassing

As was pointed out earlier, I have been curious to know how a group of papermakers from different fields would discuss the same subject. I have hoped that we could establish that all papermaking is fundamentally the same. I like to think that only details are different.

After listening to the speakers and the discussion, it might appear that none of us are too sure of what we know. This situation reminds me of the mental attitude of the early Greek skeptic philosopher. I think it was Zeno who said something to this effect, "the only thing we know is that we know nothing, but we can't be sure of it."

Although it was probably naïve to hope for complete agreement between our speakers, it seems to me that there are some areas where our opinions are close together. In the first place, most of us seem to feel that the full potential of the furnish to a machine is never fully realized. I think we could safely boil down our opinion in this matter by saying that stock preparation makes the good qualities, the paper machine makes the defects or undesirable characteristics.

We seem to agree reasonably well on the function of the headbox, even though most of us wish we had better equipment to perform that function. We also seem to agree that we should carry consistency in the headbox low in order to help us avoid fiber flocculation, bubbles, and other defects and problems. At the same time it is recognized that there is a limit to the amount of water which can be carried; this limit is due to the capacity of the machine to remove that water or the ability of our headbox and slice to deliver the smooth, level stream which we want.

We definitely feel that the slice velocity should be very close to that of the wire, and we seem in general to follow that old bit of papermaking wisdom: "stock slow, slices low; stock free, more water see."

Generally speaking, we do not feel that the location of the slice and apron, relative to the center line of the breast roll, is critical. Even on high-grade superfine rag bond, the apron position apparently may be varied over a considerable range.

There seems to be quite distinct agreement that a dandy roll is beneficial, providing enough water remains with the fiber to give fluidity sufficiently low so that the dandy can effectively level out minor inequality. Further, there was surprising agreement in the feeling that vacuum on the boxes should be kept as low as is possible.

There are one or two areas where we seem to disagree. The outstanding disagreement has to do with the use and value of the shake. We seem to be justified in surmising, however, that this disagreement can easily arise in the freeness of the stock on the wire.

Boiling it all down it appears that local conditions and the necessity of adapting what we have to what we have to make calls for some or possibly frequent modification of certain fundamental principles. Recognizing when we should deviate or just what should be done under specific conditions requires the application of a great deal of common sense, which is probably just our accumulated experience.

B. L. Kassing, Director of Process and Product Development, Nekoosa-Edwards Paper Co., Port Edwards, Wis.

Economic and Engineering Problems Involved in Building New Mills

Harold G. Ingraham

Some time ago when your chairman invited me to appear on this program, he suggested that I discuss the general subject of economic and engineering problems involved in building paper mills. That, of course, is a big subject. I much prefer to talk at random on paper mill engineering in general in the hope some of my observations may be of interest.

You have seen recent paper trade publications containing descriptions of the modernization program at the Nekoosa mill. You have seen the new machine in operation and have discussed the quality of the product that might come off that machine and other fourdriniers, but, do we appreciate all the planning that went into such a project from its conception to completion?

Every paper mill represented at this meeting has, no doubt, within the past few years, undergone a major expansion and modernization program. Many of you engineers and technical people have been actively associated with these programs and are well aware of the problems encountered in carrying them out. It takes courageous management to authorize an expansion program when faced with high construction costs, material shortages, and Government restrictions. In spite of these obstacles, the paper industry recently has seen a tremendous increase in production facilities.

What is the role of the consulting engineer in this expansion?

Over-all planning is one of the responsibilities of management. The detailed development of these programs is the function of the engineer.

This is the age of specialization. Aristotle, the Grecian philosopher, was the greatest intellect of ancient times. He was an authority on every important subject of his day. Were he to reappear on earth, he would be amazed to discover how little any of us know about any subject outside of our own sphere of activity. We have only to try reading the great masses of technical literature that flood our desks to prove the futility of trying to be a master mind.

It is difficult, if not impossible, for outsiders to come in and tell you how to make your paper. In the first place, the papermaking fiber is not a simple structure. It is about as complicated as anything can be in spite of all that has been done by the scientist and technologist to unravel its complex personality. At one of the panel discussions at the Institute last year it was observed that when this complex personality behaves in a mysterious fashion, we cover our confusion by saying that papermaking is an art rather than a science. The definition of the word, "engineering," according to Webster, is the art and science by which the properties of matter are made useful to man. A simpler definition is to call it applied common sense.

Since we cannot reduce to formula the behavior of paper stock on a fourdrinier wire, for instance, the engineer is well advised to confine himself to the mechanical aspects of papermaking and leave the art portion to the papermaker.

Harold G. Ingraham, Project Engineer, Chas. T. Main Co., Boston, Mass.

Consulting engineers specializing in pulp and paper mills should, however, be thoroughly familar with the technical problems and processes of the industry if they are to bring to a successful conclusion even the simplest of projects. Outside engineering firms do not replace company engineers who, with their more intimate knowledge of local problems, must still be responsible for the general direction of their projects. The final decisions and approval of plans and specifications should be retained by the mill management and its own engineers. The function of the outside engineer is to *supplement* the mill staff and to assume the burden of handling the multitude of details involved in any major job.

Before any detailed designs can be intelligently drawn up or satisfactory equipment selected, there must be a very definite statement of the general problem. The scope of the work as well as the objectives anticipated should be well understood by all concerned. These all require preliminary studies to assist in determining the practicability of various schemes.

Probably the most workable and understandable device available to the engineer is the flow diagram. There is nothing unique in the preparation or use of flow diagrams in the study of a process. They may be as simple as a newspaper sketch showing the route of the next day's parade for the visiting dignitary, or as complicated as an outline of a chemical plant. They are used every day to graphically explain an idea or scheme. Some go into almost photographic detail while others, as in electrical layouts, make use of conventional symbols.

Once an overzealous draftsman working on one of our preliminary flow diagrams, in order to simulate realism, drew in the picture of a fish blithely swimming around in the machine chest. Somehow or other the flow diagram got printed and sent to the field. The client's project manager, carrying on the joke, wrote us a very formal letter of protest demanding to know how the fish got in the chest and what steps were we going to take to get him out.

Paper and pulp mill flow diagrams are constantly being published to illustrate particular developments. Their use in the planning of new projects or extensions to existing mill properties is absolutely essential in clarifying the ideas of those responsible for the project.

Much valuable time and effort can be wasted in the preliminary stages if an attempt is made to develop actual layouts with no clear understanding of the scope of the project. It is during this period that properly executed flow diagrams will prove much more desirable than actual plans. The flow diagram offers a simple method for the study of an operation and at the same time, confines any discussions to the main items of equipment.

The flow diagram should be more than an approximation of the equipment. As far as possible the various items of equipment should be shown in their relative positions and sufficiently detailed so they can readily be recognized. Some attempt to keep it to scale is helpful, especially to the operating staff.

Throughout the preliminary studies, the flow diagram will be subject to constant revision. Finally, however, the practicability of the various schemes will have been determined and a workable process developed. By now it should also be possible to start preliminary layouts of the actual project. But the flow diagram now needs to be supplemented with a more complete list of equipment. The equipment list, cross-indexed with the flow diagram, will serve as a concise record of orders placed, prints received and, finally, record the shipment of each item. Each item will be assigned an equipment number and this will appear on the final flow diagram. The various pipe lines can be assigned numbers as well as the pumps, chests, and other equipment. The theoretical quantities should be carefully rechecked and the entire flow brought into exact balance.

At this point in engineering procedure, the paper mill specialist brings into the picture engineers in the organization who are experienced in other branches of engineering. This will include structural, electrical, steam, hydraulic, mechanical, and architectural engineers and draftsmen as needed. The paper mill consultant coordinates the judgment and experience of the mill engineers and operators with his own specialized personnel. The resulting decisions assure a well-planned project, set up to attain the objectives of the mill management at lowest cost.

As the over-all plan is unfolded on the drafting board, the building designs take shape. Modern paper mill buildings represent 20 to 25% of the total project cost. One of the basic rules of architectural design is that, "form follows function." A building must be designed to fit the machines it houses and the purposes for which it is intended and not be simply an enclosure of space. Economy and simplicity of design must be observed throughout with strong, clean architectural lines emphasizing the functional attributes of the building. To attain the best possible physical environment for the worker requires that careful consideration be given to heating, ventilation, lighting, acoustics, and the use of color. Windows are used sparingly since their function for working light is considered to be secondary. Glass blocks are often used where light is necessary. Very little sash is being used in paper mills today as it is an expensive maintenance item. Sash, when used, may be of aluminum or other nonrustable material.

The technique in handling artificial lighting has recently undergone much development. Fluorescent lighting equipment is now available with tubes having a life expectancy of more than 6000 hr. This is many times that of earlier designs. The intensities derived from fluorescent lights are much more satisfactory for the same wattage than that from mercury and incandescent types.

The control of noise in the paper mill, by proper acoustical treatment, may be obtained through application of sound absorption material. Noise causes irritability and disturbs the general nervous system of the employee. Much needs to be done on sonic control by the industry to reduce noise to an acceptable level. Jordans and suction rolls are notorious noisemakers. At least one paper machine builder has redesigned his suction rolls with this in mind. The high-speed chipper has created new problems for the acoustical specialist. Determination of what degree of noise level and sound wave frequency causes ear damage has not yet been clarified, but some studies are being made along these lines.

The use of color in the paper mill to produce the correct environment of the individual is mandatory. Color on a machine, on a wall, or on a traffic lane has a marked influence on a worker's morale. Color science reduces eye fatigue, relaxes mental attitude, and improves quality and quantity of production. Accidents are reduced. The selection of the proper color combinations is made through the use of color charts which select color scientifically rather than by eye alone.

We have mentioned the mechanics of laying out the paper mill process and design of the buildings. A word about generation and distribution of electrical energy and steam should be made here. Facilities for the production of electric power and steam represent a substantial portion of a paper mill project. The use of electric power in paper mills doubled in the 10-yr. period from 1939 to 1949.

In the public utility field, improved designs of central generating stations have reduced the consumption of coal, or its equivalent in oil and gas, from 3 lb. in 1921 to a little over 1 lb. of coal per kw.-hr. today. Modern paper mill power generating plants can be even more efficient. The proper selection of high pressure boilers and noncondensing steam turbine generators permit generation of a kilowatt-hour for as little as $^1/_3$ lb. of coal.

The use of metal-clad switchgear has made possible the distribution of primary power at high voltage to centrally located load centers throughout the mill. Unit substation

d motor control equipment centralizes these important rvices and provides necessary protection to equipment and rsonnel.

Control center equipment is installed in well-ventilated oms using filtered air to protect contacts and prevent over- ating of electrical parts. Long overlooked and under- veloped has been the proper grounding of electrical systems the average paper mill. A properly designed, closed loop d system of grounding is recognized as being essential. is is because of the high cost of equipment damage and wn time in case of electrical failure.

Insulation of electric cable has been greatly improved. e use of rubber for insulation has largely been superseded neoprene on some types of cable. Neoprene is more ter and fume resistant and gives longer life in elevated peratures.

Everyone is familiar with the almost fantastic increase in nstruction and equipment costs. The end is not yet in t. Average hourly rates for labor are at an all-time high. e paper industry is fully aware of these conditions and, other industries, is becoming alert to the possibilities of t reduction and product improvement through the use of dustrial control instruments.

I listened to a very excellent paper on instrumentation at e recent CPPA Tech. Sec. meeting in Montreal. This per was presented by the technical director of a large anadian paper mill. It was entirely devoted to the sound asoning that, unless we apply automatic control thinking to e operation of all processes in the pulp and paper industry, e ultimate in successful operation and acceptable product ill not be forthcoming. This is no overstatement.

Technical improvements to their products by manufac- urers have brought forth new so-called graphic panel control ystems. This is really a combined flow diagram and instru- ent board having starting buttons located on the board at e positions occupied by the equipment they control. The arious pipe lines are shown in color and the recording meters ave small, compact strip charts. Operation of the process an be seen at a glance. Use of this type of graphic instru- entation makes quick training of unskilled personnel a mple matter.

Progress in instrumentation has made possible such economi- l pulp mill operations as the so-called "one-man" bleach ant. We know of one such plant using only the part- me services of one man per shift. I suppose, the "no-man" each plant will be next. The increasing trend toward push tton operation in every phase of our daily life has prompted me wag to remark that future generations will be born with ly the thumb and forefinger on each hand.

A professor at M.I.T. recently observed that we are just ound the corner from a second industrial revolution in which tomatic machines will replace workers and electronic struments will, within limits, replace the human mind in aking decisions. Lest anyone conclude that mankind will rendered obsolete, however, the professor hastens to add reassuring note. The robot, he says, may be more efficient routine tasks but there is no danger that it will ever become e master of man. Indeed, the human brain will still be eded to solve some of the complex problems that are beyond e capabilities of the robot.

The paper mill of the future will contain many as yet un- eamed-of devices to make the lot of the papermaker easier, t we predict that paper will still be made substantially as s today for many years to come. It is obvious that if the oot cannot make man obsolete, it won't make our problems solete either. Common sense will still be needed.

mpire State (Central District)

The Central District of the Empire State Section met at the iversity Club, Syracuse, N. Y., on May 1, 1953. About individuals were present. H. D. Cook, Superintendent

Harold G. Ingraham, Chas. T. Main, Inc. and H. W. Rowe, Nekoosa-Edwards Paper Co.

of Sweet Bros. Paper Co., Phoenix, N. Y., presided as chairman.

At the election of officers Harry M. Gray, Manager of the Pulp and Paper Mill, Oswego Falls Corp., Fulton, N. Y., was elected chairman of the District. In his inaugural address Mr. Gray advised that he hoped to develop a schedule of meetings during the coming year that should prove to be attractive to individuals in the paper converting industries.

Fred O'Neil, S. Earll Church, Jr., and Robert G. Hitchings, all of the College of Forestry, State University of New York, Syracuse, were elected chairman-elect, secretary, and treasurer, respectively.

This meeting was the Annual Senior Night when the senior class of the pulp and paper course at the College of Forestry were guests of the District. On this occasion, the third in the series, the District invites an individual prominent in the industry to make the principal address for the benefit, in particular of the student seniors present. R. G. Macdonald, Executive Secretary of the Technical Association of the Pulp and Paper Industry, discussed "Personal Development Through Local Section Activity." Mr. Macdonald's address follows:

Personal Development Through Local Section Activity

R. G. Macdonald

When Mr. Gray invited me to speak on the occasion of College of Forestry Senior Night of the Empire State Central District I considered the invitation to be an honor and an opportunity to perform a service to you and to the Association.

I believe that this is the third successive year in which this special meeting has been held. The first meeting was held at the suggestion of Henry Perry who was chairman of the Empire State Section at the time. In discussing the plan of holding such meetings, I recall that Mr. Perry expressed the feeling that the Section should hold a meeting at which the senior pulp and paper students at the College of Forestry would be guests of the Section and made to feel that their imminent entry into pulp and paper industry called for an expression of welcome.

Last year, on this occasion, Vance P. Edwardes, a Consulting Engineer, and formerly Sulphite Superintendent of the International Paper Co., was your speaker. He was also a former President of the Technical Association.

A few weeks ago, I reread Mr. Edwardes' talk. It was published in the July, 1952, issue of *Tappi* and dealt with the many unsolved operating problems of some branches of the industry. It was a classic presentation and I hope that you

R. G. Macdonald, Executive Secretary, Technical Association of the Pulp and Paper Industry, New York, N. Y.

have read it. If not, you should do so and, from time to time, in future years, read it again. Mr. Edwardes, one of the great students of our industry, summed up the results of years of careful observation and made suggestions that should be inspirational to every person with your educational background who may enter the industry.

My comments must necessarily be along different lines. My experience over the past 25 years has been limited to the operation of the Technical Association so I will talk about it. TAPPI is made up of people interested in the search and dissemination of knowledge relating to pulp and paper.

During your college years you may have become acquainted with some of the great professional societies such as the American Chemical Society and The American Society of Mechanical Engineers. There are hundreds of societies dealing with technology and its many applications. Generally, a college chapter is interested primarily in holding a few meetings during the year when suitable speakers can be obtained who will talk on some phase of their specialties.

TAPPI does not have any college chapters but its Local Sections welcome students to its regular meetings. Our Maine-New Hampshire, Kalamazoo Valley, Lake States, and Pacific Sections hold meetings such as this at which time special attention is paid to students in colleges devoted to pulp and paper technology. In Kalamazoo, Mich., for example, one meeting of the Kalamazoo Valley Section is devoted to the presentation of summaries of the graduate theses of the seniors of Western Michigan College.

The national association itself frequently finances research projects at pulp and paper schools and enables some students to assistion the solution of current important technical problems. I believe that a project dealing with water vapor permeability is being considered for study at the College of Forestry.

The Technical Association was founded in 1915 to enable the relatively few technically trained men in the industry to hold meetings and to exchange information of mutual value. The group was small, numbering about 200 at the end of its first year. The Association had no money to employ an office staff nor to do any publishing. Thomas J. Keenan, who at the time was the Editor of a magazine called *Paper*, acted in the capacity of Secretary and was able to publish the meeting papers in his magazine. While he was Secretary, a group of individuals and companies got together to establish a publishing organization called the TAPPI Publishing Co. Sufficient funds were raised to publish one annual volume of meeting papers but since they did not raise enough money to carry on the work the company went out of existence. The magazine *Paper*, however, came to the rescue and minimized the cost of publishing by saving the type plates of the articles appearing during the year in its monthly issues. It also sold some advertising space which permitted the annual to carry on under the name of *Technical Association Papers*. When *Paper* ceased publication in 1921 and was purchased by the *Paper Trade Journal* the Association meeting papers were also published weekly in that publication and *Technical Association Papers* continued to be published, using the plates previously used by the *Journal*. In 1949 the Association discontinued its long relationship with the *Journal* and started its own monthly magazine—*Tappi*. This change came about partly, by the desire of the *Journal* owners to change the terms of their relationship with the Association and partly by the desire of many members to establish an independent magazine. As a result of this change in policy the Association is able to give its members a publication of about 200 pages each month, as compared to about 50 pages through the medium of the *Journal*.

In 1921 Mr. Keenan was succeeded by William G. MacNaughton as a full-time Secretary of the Association. The membership at the time was 346 individuals. He continued until 1927, by which time the membership had grown to 760 individuals. He left to accept a position as Engineer for the News Print Service Bureau. In fact, Mr. MacNaughton, who had been Manager of the Inland Empire Paper Co. in Spokane, Wash., had accepted the position in 1921 to accommodate the organization for 1 year. He was a great student of pulp and paper and had a remarkably retentive memory. His contribution to the industry was largely personal. At the time, there was but little published information about pulp and paper manufacture. In 1916 George Witham had written a practical book on "Modern Pulp and Paper Making," and in 1920 Edwin Sutermeister brought out his well-known book on the "Chemistry of Pulp and Paper Making." There developed a great urge on the part of papermakers in the United States and Canada in 1918 to prepare a set of textbooks. Their efforts through a Joint Committee on Vocational Education resulted in the publication of the five volumes of "The Manufacture of Pulp and Paper." A large number of individuals cooperated in preparing the chapters in these useful textbooks which were published in 1921 and successive years. Mr. MacNaughton therefore carried on a very heavy correspondence with individuals and companies and gave them the benefit of his very wide knowledge. In essence, he was a consultant and would talk or write reams of information especially for the benefit of young technical men, new to the industry.

One day near the end of 1927 Mr. MacNaughton asked the writer if he would be interested in succeeding him so that he could go with the News Print Service Bureau. The writer, at the time, was a member of the staff of *Chemical & Metallurgical Engineering*, a McGraw-Hill publication. Upon accepting the position the writer found himself working for both organizations; by day for *Chemical & Metallurgical* and by night, for a month, for the Technical Association.

Not being qualified to continue the excellent consulting services of Mr. MacNaughton, the heavy correspondence of the type engaged in by him gradually tapered off. However, an industry advancing in technology as rapidly as the pulp and paper industry needed the kind of service that such a central clearing house as TAPPI could give. The McGraw-Hill textbooks on "The Manufacture of Pulp and Paper" presented basic practical information but were destined to remain unchanged in text for several years. They needed to be supplemented with a constant flow of up-to-date information.

Through the efforts of Fred Clark, B. W. Schribner, Roger Griffin, and Helen Kiely there had been a gradual accumulation of testing procedures. It was therefore possible in 1928 to bring together and issue a cloth-bound volume of *Paper Testing Methods*. About the same time Miller and Swanson at the Forest Products Laboratory in Madison, Wis., had prepared considerable material which was issued by the Association as a cloth-bound volume called "Chemistry of the Sulphite Process." Some years earlier Clarence J. West, while with Arthur D. Little, Inc., had prepared a "Dictionary of Paper Making." This pamphlet was expanded and brought up to date and issued as a cloth-bound volume. All these books were financed by the Lockwood Trade Journal Co. and met a real need.

Following World War I there had been a considerable influx of technically trained men into the industry. There was a great demand on the part of the industry for supervisory foremen. It was this need that led to the preparation of the five texts on "The Manufacture of Pulp and Paper" and the establishment of a very extensive vocational education program. The Institute of Industrial Arts, established at Gardenvale, Que., was started to direct correspondence courses in a large number of mills that had their own training programs. Some companies set up operating apprenticeship programs. The writer entered the industry in such a program at the Pejepscot Paper Co. in Brunswick, Me., in 1922.

The programs of the two national meetings of the Association were expanded greatly and attracted the attention of the

xecutives of the industry who began to give real support to ne Association. Many new committees were organized nd were active.

It soon became evident that one of the industry's great eeds was a common language. This called for the develop- ent of testing methods which would do much to create a nguage based upon suitable measurements and led to our resent TAPPI Standard Testing Methods, Specifications nd Recommended Practices. They were started in the rm of a loose-leaf manual since it was felt that they would e changed from time to time as more and more research sults became available. They still appear in this form, a stimony to the dynamic nature of the subject.

With the growth of the National Association in the expand- g industry there was a growing demand for more meetings, ecially gatherings that would not be attended by the large mber of individuals who attended the national meetings. his requirement led to the formation of Local Sections hich were established in pulp and papermaking centers. he first section was organized on the West Coast as the acific Section in 1929 where the need of such an organization as magnified by its geographical remoteness from the East.

Other Local Sections followed: Lake States in 1930; Delaware Valley and Kalamazoo Valley in 1931; New England in 1932; Ohio in 1935; Empire State in 1938; Maine-New Hampshire in 1940; Chicago in 1943; Lake Erie n 1951; and the Southeastern Section in 1952. These ates are a little misleading since all of these Sections existed as local pulp and paper clubs, more or less on a probation asis, for a year or more before they received charters as Local Sections of the Association.

These local groups were permitted to grow and develop argely on their own resources with some financial assistance rom the national organization. Gradually, however, it has een possible to pull together some of the loose ends without disturbing the independent operation and leadership so ecessary to perpetuate such local organizations.

Under our present organization there is a strong network eing together the Association and the Local Sections. ndividual members of the National Executive Committee re appointed by the President to represent the committee n each Local Section. There is also a Local Section Com- ittee in the Executive Committee whose responsibility it is o study Section organization problems and to meet with ection officers at the Annual Meeting to discuss their prob- ms. Their mutual efforts have resulted in the preparation f a Manual on Local Section Organization which is revised nnually and is published in the *TAPPI Year Book*.

Each year at the Annual Meeting of the Executive Com- ittee the chairmen and other officers of the Sections are resent to listen to the discussion of National Association roblems and to make suggestions.

One of the great benefits of the Association magazine *Tappi* as been its ability to report in considerable detail the papers nd discussions presented at Local Section meetings. This as done much to raise the general caliber of the meetings nd of the papers presented. At present, all of the Sections e performing well and some have initiated rather ambitious rograms which have been successful.

Many improvements are possible in conducting the work of ocal Sections. An ever-present problem is created by the hange in administrations from year to year. Most of the ctions elect new officers every year and make new appoint- nts of program chairmen, etc. This practice is good in at it gives more individuals an opportunity to develop as aders but it creates an annual disturbance in the relations tween the Sections and the national organization. Since e good outweighs the bad there is no reason why this ocedure should not be continued, especially since ways and eans are gradually being devised to minimize the interrup- n. It is hoped, however, that, in time, self-interest on the rt of the Sections will lead to smoother relations with the National Association, especially in the first few months of the Fall. After considerable correspondence most Sections meet the requirements that are so beneficial to themselves.

The Association through its monthly magazine *Tappi* is willing to devote a large amount of expensive space to the publicity of Local Section activities. To gain the maximum benefit from such an opportunity, it is necessary for Sections to organize themselves early so that they can obtain these benefits. *Tappi* is published rain or shine on the 15th of each month. Before one issue is out work has begun on the preparation of the next issue.

In any organization it is necessary for the executive group to decide who is to do what and when and how. If a meeting is to be held in October publicity intended to attract attendance needs to appear in the September issue. To accomplish this it needs to be in the Editor's hands by the tenth of August. Since most Section elections are held in May or June it is necessary for the Section executive committee and its program committee to establish its meeting schedule in the early part of the Summer, especially for its October meeting. Some Sections go so far as to determine all of their meeting dates and tentative subjects during the Summer. It is often difficult to be more definite than this insofar as speakers and panel members are concerned but the schedule of the magazine and meeting notices sent out by mail are hard taskmasters.

The meeting itself is, of course, of prime importance. It should be interesting and important to the individuals who are expected to attend. There is little time available to organize such meetings. However, this difficulty can be overcome to some extent by distributing the responsibility among a number of individuals. By looking ahead it should be possible to plan some very good meetings. For this reason the meetings toward the end of the season are usually better than the meetings held earlier.

Following the meeting there is the job of reporting the meetings for *Tappi*. Some Sections do a good job but for others the job of reporting appears to be a chore. It should be a relatively simple task since it deals with the known, in contrast with the unknown factors involved in the preparation of the meetings and the problems connected with the handling of the meetings themselves.

The reporting of the details of a meeting is of considerable importance to a Section. It lifts the status of the Section and its meeting from a purely local affair up to national stature. It broadens the interest in the meeting from the 100 or more that may be present to the 5600 members of TAPPI who might have liked to have been present. Since this is not possible the next best thing is to let these absent members benefit as much as possible by being able to read a comprehensive report of the proceedings.

As you have noted this talk has degenerated into an editor's gripe. It is the same kind of a gripe that your professors have in reference to your work at the College of Forestry. It is partly their own fault since they feel responsible to equip you with the technical training that you will need later in your work in the pulp and paper industry. In every technical school studies in the liberal arts need to be minimized because of time limitations. This is unfortunate since you will need a profound grounding in languages, especially the English language. A knowledge of English and a love for self-expression will carry you a long way.

Throughout your industrial life you will need to be able to think, act, write, and talk effectively. To be able to accomplish these ends you cannot have too much background in the fundamentals of chemistry, physics, mathematics, and the English language. I mention these subjects because they are basic. Engineering technology and business administration are all outgrowths of these fundamental subjects. If you have not done too well in any of them in the College of Forestry do not despair. You have many years ahead of you that can be put to good use if you continue to be a student.

Of these subjects, the one that will do you the most good is the study of good English and the use of this language in expressing yourself in writing and talking. I am, of course, assuming that you will have the know-how and the know-of that will be worthy of such expression. Your standing among your fellow men will depend to a large extent on your ability to express yourself so that they can understand you and appreciate the true depth of your stock of knowledge.

There are skills in expressing yourself that I will not discuss now. They can be developed. The important thing is to master good English first; then talk and write as extensively as you can. There is no substitute for this kind of experience.

Knowing the demands of the industry I realize that you will have little difficulty obtaining a job and at a satisfactory compensation. However, it is a fairly well-established fact that in the course of a year more than 500 out of 1000 of you will change your jobs either within or without your company.

Each year the Technical Association is the medium through which 100 or more individuals will change their company connections. Having joined the Association staff during the prosperous years leading up to 1929 and then struggling through the depression years of the 30's I realized how important it was for the Association to serve as a clearing house to bring men and jobs together and even to create jobs to this end.

The Association can do no more than act as a clearing house; the real sales job has to be done by the man who is seeking a position. I have read hundreds of letters of application and have helped many individuals in this important presentation. Many of these letters were written by men of real ability. Some expressed themselves well while far too many were unable to do a real selling job in presenting the most valuable commodity they had; namely, themselves. The letter, in most cases, is all the prospective employer has in hand to enable him to make a decision leading to an interview. The interview is the second barrier and its success depends on self-confidence and skill in presenting your personal sales story in words.

How can you acquire these skills in self-expression? Your job may be such that you may not have very much opportunity to express yourself at length. If such is the case you will need to find opportunities of expressing yourself where you can find them. There are forums of sorts almost everywhere, including churches, civic organizations, social clubs, etc.

You are particularly fortunate if you are located somewhere where you can participate in the work of a chapter of a professional society. In fact, it is worth while to travel a fairly long distance to attend such meetings—not only to listen to someone who has something worth while to say but to say and do something yourself. Ask a good question or add something to the discussion on the subject being considered.

You will be surprised to find out how easy it is to get on a committee and to assist in the leadership of professional groups. You can make this kind of progress largely by default. The inclination to let George do it is prevalent everywhere. It is one of the reasons why organized society is frequently confronted with undesirable leadership. It is why we sometimes have the types of civic government that we have since bad leadership can drive out good leadership if it is permitted to do so, as it often is by surrender and indifference.

There is one job that you can get in any local organization such as this Section. That is the job of reporting the meeting either for the record or for a publication serving the Section. From year to year Sections have good or so-so reporters. Editors can often make poor reports look good but not much can be done if no report is prepared. The problem, which usually is not a great one, gets back to English language-phobia, the failure to do a good reporting job because it requires effort, attention, and command of a language.

The challenge of language will confront you when you have to make your first report to your superiors in your company. You will have the information that you have been instructed to obtain. This information may be in the form of data. You will present it in some form; the form depending somewhat on the wishes of the person who is to receive and make use of the report. One time I visited a well-known consulting engineering laboratory and was shown three bound reports to a company on a certain major project. One report contained about 500 pages written for the company's engineering and technical organization; a second report contained 100 pages for the mill management, and the third report contained 20 pages for the Board of Directors. Each report had to say the same thing but with different objectives.

When you have the opportunity and privilege of presenting a paper before a technical organization the approach becomes somewhat different. The company report is usually dictated by forms that have been established by administrators who know what they want and exactly how they want it. In the professional society where you will address yourself to men of your own professional level or to individuals of kindred interest, the object necessarily must be to deal with broad or fundamental principles.

This talk has not been devoted to the problems of pulp and papermaking. For the past few years you have studied the ways of investigating such problems. Instead, I have tried to give you a little background relating to an organization that I hope you will consider your own, and I have stressed the particular field of personal development that this Association or others of a similar nature can help you attain. You are entering one of the great industries. It is made up of fine people whom you should know. Get acquainted with them through organizations such as this Section.

Empire State (Metropolitan District)

The Metropolitan District of the Empire State Section held its regular dinner meeting at Fraunces Tavern, New York City, on April 14 with Chairman Paul L. Haggerty, George La Monte & Son, Inc., Nutley, N. J., presiding and about 70 members and guests in attendance. Officers for the coming year were elected as follows:

Chairman—Ralph W. Kumler of the American Cyanamid Co.
Chairman-elect—John C. Rice of the Lowe Paper Co.
Secretary-Treasurer—John H. Doherty of Union Bag & Paper Co.
Members at Large of the Advisory Committee—A. V. Arenander, Jr., of West Virginia Pulp & Paper Co.; Walter T. Cusack of Aldine Paper Co.; L. E. Georgevits of Titanium Pigments Corp.

Consumer unit packaging was discussed by a panel of experts with L. C. Cartwright of Foster D. Snell, Inc., as moderator. Charles M. Woodcock of the General Foods Corp. opened with an informal discussion of the importance of proper packaging and the necessity of using materials giving moisture vapor resistance, grease resistance, and frequently odor and gas resistance. He also stressed the importance of aesthetic appeal. Paul K. Wolper of Riegel Paper Corp. continued this theme and pointed out how the desirable functional properties could be brought about by modern converting methods, such as the various processes of surface coating and laminating. Walter L. Hardy continued the discussion with particular reference to the testing of food packages and food packaging materials. The usual excellent question-and-answer period followed the talks

Packaging for the Food Industry

C. M. Woodcock

Companies packaging foodstuffs appreciate the importance of acquainting their suppliers of packaging ma-

C. M. Woodcock, Packaging Research, General Foods Corp., Hoboken, N. J.

terials with the specific requirements involved in any specific case. The food package is recognized as one of the most important factors in insuring that a foodstuff reach the consumer in good shape.

Every property of a functional packaging material is important—moisture vapor resistance, water resistance, grease resistance, all the various types of "strength," stretch, shrinkage, gas and odor impermeability, transparency, opacity, printability, as well as many others. Certain of these properties are more important for certain foodstuffs than others, for example, water vapor impermeability is of the utmost importance in packaging a highly hygroscopic material such as soluble coffee. Similarly a product such as coconut requires a highly grease-resistant package. A tea package must keep the product aroma in and keep foreign odors out.

Packages serve as salesmen for the products they contain, especially in the food industry where sales are frequently the result of "impulse buying." Appearance, "feel," the use of gadgets such as easy opening features, pour spouts and the like, and re-use features all offer extras that have definite merchandising value. Such extras are limited by the increased costs involved.

The importance of the many factors entering the problem is frequently determined by the use of extensive consumer research and testing organizations by the food industry. These factors are the subject of continuing study by all large food companies. The food industry welcomes and needs the cooperation of the paper industry and all other packaging supply producers.

Converted Paper Packaging Materials

P. K. Wolper

Mr. Woodcock has very ably presented the requirements of the food industry with respect to packaging materials. He has indicated the four elements of a desirable flexible package material, namely, good appearance, adaptability to automatic packaging equipment, product protection, and low cost. All of these elements have a universally acknowledged importance. Yet if an attempt were made to single out the one element of top significance, the chances are that protection would be chosen.

Of what does the element of protection consist? Again we are in debt to our first speaker for the answer. Moistureproofness, greaseproofness, gas and odor impermeability—these and other properties are included in the concept of the protective function of sheet packaging materials. Some of the fundamental reasons why these properties are required have been presented.

Granted the necessity of the protective function of a package material, how are these needs met by the paper manufacturer? In answer to this question, we will consider briefly some aspects of paper converting.

Converting operations are a necessary adjunct to the mill producing packaging grades of paper. Converting methods expand the possible types of packaging materials many times. The very nature of the processes and their raw materials results in flexibility of operation and versatility of product. The genealogist may find extreme difficulty in concisely recording the history of several generations of a prolific family. In much the same way, the converter has a problem when confronted with the products of a few unit processes and the larger number of available raw materials. It might be possible to compute mathematically the number of permutations or combinations of converted paper packaging materials. However, we are not so much interested in the quantity of types as we are qualitatively in the diversification of types and their protective attributes or functions.

P. K. Wolper, Riegel Paper Corp., Milford, N. J.

To be more specific, we will discuss paper converting, on a basis, first, of methods, and secondly, on the basis of materials. There are three principal converting operations. The first comes under the heading of graphic arts, and is a whole subject in itself. For our purposes, only passing reference to this can be made. You are, of course, all familiar with the functions of printing on the package. The print job creates eye appeal and carries the brand identification, product composition, and end-use information for the ultimate consumer. The dense surface of glassine and supercalendered papers plus the visual factors of transparency or those of colored or opaque grades makes these papers desirable from the printing viewpoint. Aniline printing of glassine has been standard practice for a number of years, while the use of rotogravure printing is growing.

The second group of converting operations is surface coating. Surface coatings are applied to paper in the molten state as in waxing or hot melt applications. Coatings may also be applied from solvent systems or by extrusion methods. No matter which method is used, the coatings first add to the visual functions of the packaging material and, more importantly, also add valuable protective functions.

Refined paraffin wax is the principal raw material used for wax or hot melt surface coatings. It is a nontoxic, highly moistureproof, low-cost material. Paraffin wax films have the disadvantages of being readily scuffed or smeared and they do not heat seal well. For this reason paraffin wax may be modified with small quantities of other materials such as microcrystalline wax, butyl rubber, or polyisobutylene to improve heat sealing. High melting point waxes may be added to improve the durability of the wax film. In no case is the modification of paraffin carried out to a point where its original properties are destroyed. All of these blends of paraffin wax can be applied on conventional waxers at temperatures of 220°F. or lower. The hot melt coatings are blends of various waxes with substantial quantities of resins or synthetic film formers. These coatings require special equipment and much higher application temperatures. The coatings are characterized by high surface gloss and positive heat sealing, although their moistureproofness is appreciably lowered in comparison to the paraffin wax films.

As we have indicated, coatings may also be applied from solutions or dispersion in appropriate solvent systems. In general these coatings possess positive heat sealing and very good visual characteristics. Depending upon the raw materials and their formulation, a range of moistureproofness can be obtained that will vary between the limits defined by an equal quantity of a paraffin wax film to practically no moistureproofness at the other extreme.

The principal solvent coatings and some of their characteristics are as follows:

1. Cellulose nitrate (nitrocellulose). The least expensive of this class of materials. Can be formulated so as to either be heat sealing or nonheat sealing. Similarly this material can be made either moistureproof or nonmoistureproof. Cellulose nitrate films are inherently greaseproof.
2. Cyclized rubber (pliolite). A more expensive coating but one with exceptionally strong heat seals and a high level of moistureproofness.
3. Butadiene-polystyrene copolymer. Similar to pliolite, can be blended with paraffin wax to cost advantage.
4. Vinyl copolymers. These coatings possess only a medium of low moistureproofness. They are quite greaseproof, however, and they find use in special applications where the other types do not fit in.
5. Thermosetting coatings. Because of the high curing temperatures required, these coatings cannot be used with glassine. They can be used with advantage on supercalendered papers. Their chief characteristic is a very high surface gloss. In addition they are resistant to oils, solvents, and water vapor.

The third and newest type of surface coating method is extrusion. At the present time polyethylene is the principal film being extruded, although Saran film is used in limited quantities for this purpose. Polyethylene films are tough and

flexible and possess a medium level of moistureproofness. Polyethylene films are chemically inert and have excellent heat-sealing properties. Greaseproofness must be described with qualifications. Polyethylene appears to act very much like a blotter does with water, since it absorbs relatively large quantities of fats or oils. Depending upon the oil or grease, this absorption is limited by the fact that the absorbed oil acts as a plasticizer for the polyethylene causing it to lose its original film characteristics.

Laminating is the third general class of converting processes. Like surface coating, laminating adds principally to the protective function of the paper as a packaging material.

The materials used as bonding agents in laminating are few in number. One group is used in hot melt laminating and is composed for the most part of microcrystalline waxes or modifications thereof. This group of laminants has good moistureproofness, flexibility, and adhesive properties. A second group of laminants consists of aqueous or organic solvent dispersions of dextrins, synthetic resins, and rubber compounds. The latter group is characterized by excellent bonding quality, even under adverse use or storage conditions. The solvent-applied laminants are not generally moisture or grease-resistant. Their use is restricted to a large extent, for laminating aluminum foil to paper.

One of the most important facts about laminating as a converting operation is that it enables the converter to combine different sheet materials together. The whole roster of sheet materials can be exploited, so that it is possible to find in today's flexible packages combinations of all types of paper products, aluminum foil, and the synthetic films.

To this point we have attempted to indicate how converting techniques are used to create packaging materials of varying composition and properties. It may be of interest then to examine some of these sheet materials from the viewpoint of their protective properties. More specifically, we have selected moistureproofness as being the most important single protective property. The following table shows how this property is dependent upon the method or materials used in its manufacture. The table also serves to show some typical applications of converted paper in food packaging.

In conclusion, what are the future trends of consumer unit packaging? Our ability in prophecy is strictly limited, but there are certain obvious factors that cannot be ignored. The prime manufacturer—the food processor—will continue in the future to develop new or better products that will demand new or better protection, appearance, and handling characteristics from their packaging materials. It will be the job of the paper manufacturer to fill this demand with paper products of improved and consistent quality at the lowest cost possible.

Testing Food Packages and Food Packaging Materials

Walter L. Hardy

EVERY property of a packaging material and of a functional package is of measurable importance in food packaging. Among these we can consider the physical properties (tensile, tear, stretch, burst), moisture and water resistance, grease resistance, gas and odor permeability, effect on product flavor and aroma, opacity to damaging light, sales appeal. Everyone of these properties is worthy of full and detailed discussion.

Essentially the purpose of a functional food package is to permit the consumer to find in the product the aroma, flavor, and consistency which were present at the time of manufacture. Changes in these product characteristics during shipping and storage can be brought about by package permeability to water vapor, oxygen, carbon dioxide, and foreign odors as well as the presence of odor and flavor in the packaging material itself.

The package engineer should start with the salesmen's cliché: "know your product." What happens to the flavor,

WALTER L. HARDY, Foster D. Snell, Inc., New York, N. Y.

Package Materials

Type	*Paper*	*Ream weight, lb.*	*Coating or laminant*	*Ream weight, lb.*	*Grams/100 sq. in./24 hr.* Flat	Creased	*Use*
Waxed	Glassine	20–25	100% paraffin	3–4	0.20–0.40	3.0–5.0	Snack foods—prefabricated bags
Waxed	Glassine	25	100% paraffin	5–7	0.10–0.20	2.5–3.5	Cereal foods liner
Waxed	Glassine	25	Modified paraffin	5	0.20–0.40	3.0–5.0	Crackers—biscuits
"Dry" waxed	S.C. sulphite or kraft	25	100% paraffin	5	15.00–30.0	High	Macaroni liner
"Wet" waxed	S.C. sulphite or kraft	25	100% paraffin	10	0.70–2.00	9.0–12.0	Breadwrapper
Coated	Glassine	22–25	Nitrocellulose	3	0.40–0.60	4.0–6.0	Tobacco wrap
Coated	Glassine	22–25	Cyclized rubber	3	0.15–0.25	0.4–0.8	Snack foods
Coated	Glassine	22–25	Butadiene-polystyrene	3	0.15–0.25	0.3–0.6	Snack foods
Coated	S.C. sulphite or kraft	25–32	Nitrocellulose	5–8	0.70–1.40	5.0–8.0	Coffee, pouch
Coated	Glassine	22–25	Vinyl copolymer	3	2.50–4.00	5.0–8.0	Heat-sealed greaseproof liner
Extruded	Glassine or S.C. sulphite or kraft	25–50	Polyethylene	7.5	2.50–3.50	2.5–3.5	(Chemicals, medicinals, metal goods)
Extruded	Glassine or S.C. sulphite or kraft		Polyethylene	15.0	1.30–1.80	1.3–1.8	
Extruded	Glassine or S.C. sulphite or kraft		Polyethylene	30.0	0.60–1.00	0.6–1.0	
Laminated	Glassine	2 × 25	Microcrystalline	7	0.30–0.60	0.30–0.60	Premixed bakery goods
Laminated	Glassine	2 × 25	Microcrystalline	10	0.20–0.50	0.20–0.50	Premixed bakery goods
Laminated	Glassine—S.C. sulphite or kraft	2 × 25	Microcrystalline	5	1.00–2.00	2.00–4.00	Oleo—dye packaging
Laminated	Glassine—S.C. sulphite or kraft	2 × 25	Microcrystalline	15	0.30–0.50	0.50–1.00	Frozen foods—locker wrap
Laminated and coated	Glassine	2 × 25	Microcrystalline wax	7			Snack foods—bags
			Nitrocellulose	3	0.15–0.25	0.20–0.40	.....
Laminated and coated	Glassine	2 × 25	Microcrystalline wax	7			
			Cyclized rubber	3	0.10–0.15	0.20–0.40	.....
Laminated	Glassine—foil	25 + 15	Microcrystalline wax	7	0.01–0.02	0.15–0.30	Chewing gum wrap
Laminated	Glassine—foil	25 + 15	Resin or latex	1	0.01–0.02	0.40–1.00	Soup mix, dried milk
	300 MST Cellophane 54				0.40–0.60		
	140 N_2 Pliofilm				0.60–0.70		
	100-gage Saran 517 in.				0.16–0.20		

aroma, and consistency of your product if the moisture content varies. What is the effect of the ingress or egress of oxygen or carbon dioxide? Will light of certain intensity and wave length influence the product? Is the product susceptible to adsorption or absorption of foreign odors? Will the product exude oils, shortenings, or similar ingredients? Will the aroma and flavor deteriorate under shipping and storage conditions?

When these factors have been established a selection of two or three potential packaging materials can be made. These can be tested for the degree of functional protection found to be necessary from the analysis of the product. For example, a product may require moderate moisture control, protection from oxygen, elimination of carbon dioxide, and high grease resistance. Following the selection of possible packaging materials, actual packages should be prepared and tested for suitability. The foregoing may be summarized: (1) know your product, (2) select the packaging materials, then (3) test the finished package.

As a food packer or a supplier of food packaging material, of what value is the knowledge that a particular material will be impermeable to turpentine, when the product you are packaging is peanuts? Water vapor transmission rates determined at 100°F. are of little value to a frozen food processor. Will impermeability to vanilla of a given material be of value when your product is flavored with nutmeg or a source of contaminating odor may be crates of cabbage in a warehouse?

Only one conclusion can be drawn from these questions and implied answers. There is no substitute for a test of the product in the proposed package under conditions comparable to those to be found in shipping and storage, accelerated if necessary. The basis of the test should be an organoleptic, or sensory, evaluation of the product before and after testing.

Frozen foods should be tested after aging under freezer storage conditions. All other food products should be tested under the most extreme conditions existing in your marketing area. For example, if you market your product nationally, conditions prevailing in the Gulf Coast area (approximately 120°F. and 90 to 95% relative humidity) should be duplicated. Let me mention one persistent test procedure error here. Tests performed at static conditions of temperature and humidity are of minimum value. Since they do not duplicate the dynamic conditions normal to any locale, the effects of package "breathing" are eliminated. I heard one speaker, at a recent Packaging Institute meeting, state that stapling of his package was equivalent to heat sealing. It is obvious that his test conditions were static. If he had tested under normal cyclic conditions, he would have found a considerable difference between the two methods of closure.

I will not attempt to establish an accelerated test procedure. It would be distinctly uneconomical to package against Gulf Coast conditions, if your marketing area is the north Central states. I would suggest you check the U. S. Weather Bureau in the proposed marketing area, and from these data establish the static and cyclic extremes of ambient conditions for your test.

Having established your product requirements and the test conditions, prepare actual packages from the selected packaging materials. Subject these to the established test. Test evaluation is then based on a comparison of the aroma, flavor, and aftertaste of the tested product against the original as manufactured. An examination should also be made of the product and package appearance. Any deterioration in product or package based on the organoleptic test or the observation is cause for rejection.

For organoleptic test procedures, I refer you to numerous articles in the literature and especially to those by Mr. Cartwright, and his associate Mrs. P. H. Kelley.

The above procedure, we believe, will alone provide the proper design of a package for product protection from the manufacturer to the ultimate consumer.

Now, let us consider the second function of our package—that of sales appeal at the point-of-purchase decision. Have you selected packaging materials and a package design to create sales at the most important point in your merchandising system?

There are some of you who believe that package appeal is unimportant—that your advertising campaigns will create your demand. Let us look at the record. In a recent survey made by the Du Pont Co. in 35 supermarkets covering 1845 shoppers, it was determined that only 33.4% of the purchases were planned in advance and bought as to specific item and brand name. Thus, 66.6% of the shopper decisions were made at the point of purchase. Of this 66.6%, 26.7% were planned purchases as to item, unplanned as to brand. One and a half per cent involved substitutions of item and/or brand. Most important is that 38.4% of the purchases were completely unplanned when the purchaser entered the market. In other words, for every ten items the shopper purchased, the decision on item and brand was made at the point of sale for four of them; and on brand only, for three.

When the shopper is making these vital decisions, what influence do you have other than package appeal. The right package design could potentially increase your sales 66%.

The most important features in package design, in my opinion, are simplicity and clarity. Some of you have a tendency to put everything on the box or label with the exception of your annual report to the stockholders. The fact that the consumer pays very little attention to your instructions and other copy is unimportant. Consider what happens when she walks by this miniature, wordy billboard. According to the American Optometric Association, approximately 35 million women in America wear glasses, of which 40% or 14 million, refuse to wear them in public. It is estimated that 20 million more should wear glasses but do not for one reason or another. This makes a total of 34 million shoppers who look at your label or box design with impaired vision. Unless your copy is clear and bold with good contrast she will not see it.

Also consider the number of color-blind shoppers. If you do, you will not use red letters on a pink background as you will find on a current package for a window cleaner. A person blind to the red spectrum can hardly see that package, much less the trade name.

Lastly, consider your packing materials and procedures. American industry will pay a bill this year of approximately 200 million dollars for essentially bad packing in domestic shipping. Do you advertise expensive items to the potential thief by means of container copy? Domestic rail and motor freight losses due to pilferage will be approximately 4 million dollars. Are you shipping containers properly marked as to source and destination? Improper marking will be the essential cause for a 20 million dollar loss. If you should consider export shipments, these figures become even more appalling. What are your shipping losses? Have you ever checked? After all, you are paying the bill—it is part of your over-all costs.

Meeting of May 12

The Metropolitan District celebrated its last regular meeting of the season, Tuesday, May 12, by holding Ladies Night at Fraunces Tavern with about 70 members and guests in attendance.

The Museum of the Sons of the Revolution in Fraunces Tavern was thrown open to the group prior to the meeting. Following the dinner an excellent talk was given by Donald Lowe, president of the Lowe Paper Co., in which he showed many beautiful colored slides illustrating the recent European trip which he made as a representative of the Port Authority and also for the Lowe Paper Co., and on which Mrs. Lowe accompanied him. Mr. Lowe not only described and illustrated his trip but also pointed out the differences between the basic economic and political philosophies of Europe and America.

Chairman Paul Haggerty introduced the new officers elected at the last meeting: Ralph W. Kumler, chairman; Jack C. Rice, chairman-elect, and John H. Doherty, secretary-treasurer. Mr. Kumler announced committee appointments as Program Chairman Lew R. Ayers; Publicity Chairman Lou E. Georgevits, and Membership Chairman Pat Palmaccio. Members-at-large of the Advisory Committee are A. V. Arenander and Walter Cusack. Bill Willets was appointed the district's delegate to the Empire State Section.

W. R. Willets, *Recorder*

Chicago

The Chicago Section met at the Chicago Bar Association Rooms, Chicago, Ill., on April 20, 1953.

E. H. Balkema, General Purchasing Agent of Colgate-Palmolive-Peet Co., Jersey City, N. J., was the principal speaker. He presented a paper on "Quality Control from a Buyer's Viewpoint." This paper follows:

Quality Control from a Buyer's Viewpoint

E. H. Balkema

It is my experience that the term quality control is not fully understood. It means different things to different people. Many people adapt it to meet the need of the moment.

To many producers and buyers, quality control is ever changing and that is not good. To form a basis for this discussion, let us see how Webster defines "quality" and "control." One definition of "quality" is "proper or essential being," while a definition of "control" is "to keep within limits." Therefore, we will consider quality control as "keeping within limits of proper and essential being."

Who is responsible for setting the limits of proper and essential being? This is a prerogative in its final form of the buyer. It is not, however, the prerogative of the buyer to specify *how* to reach this result. The mills and the converters know their equipment and their limitations better than any buyer. Therefore, they must assume this right.

The setting of the limits of proper and essential being or quality control is a cooperative undertaking. It cannot be complete if either the buyer or the seller cannot or does not fulfill his obligations. If complete and accurate specifications are not given by the buyer to the supplier, then how can he expect to get what he wants regardless of the quality control measures available to the supplier? There is a definite need within the packaging industry for this cooperation. The producers of paper packaging materials through their national associations have done little to promote this idea.

My associate, Mr. Baldwin, relates the following experience in the Navy Printing Plant at Washington, D. C.:

"During World War II, the Navy's Bureau of Supplies and Accounts issued a booklet to the Supply Officers giving them advice on securing initial supplies for a ship newly commissioned. One paragraph referred to the buying of printing and contained a statement along the following lines:

" 'When placing an order with a printer, it must be carried in mind that the printer is completely devoid of good judgment. He will print a fly speck if it appears on your copy. Be sure to give him complete information and clear and accurate copy.'

"The reference to the printer's judgment is annoying, but through experience one learns that it is not the printer's role to use judgment insofar as copy and specifications are concerned. He must have complete instructions."

Many of the systems now being used for the purchasing of paper packaging materials are as outmoded as a Model "T" Ford. Many executives who are in close contact with these outmoded systems find it impossible to see what is wrong with existing setups. For improvement of methods, it is necessary to get a "long-range" view through a detailed study of the whole problem involved in any individual situation.

Research and experience have brought out many basic principles which must be followed in order to have a successful system. This system must result in:

1. The desired quality of paper packaging materials.
2. A low net cost.
3. A low waste factor in the packaging plant.
4. A minimum of machine down time caused by poor quality or off-specification packaging materials or lack of packaging materials when needed.
5. Permitting the packaging department to operate at minimum cost and maximum efficiency.

The buyers of paper and board packaging materials need help from their suppliers. The suppliers need more help from their national associations. Do you realize that today there is no uniform set of trade customs within either the paper or board converting industry?

Let us review the cooperation which we as buyers offer our suppliers on "keeping within limits of proper and essential being" or quality control.

ART WORK

The first step is to provide the artist with a complete set of specifications which he must use in preparing the art work. Remember the art work is prepared by an artist. He may or may not be familiar with the production processes and limitations available for translating the art work into the finished packaging materials. To permit economical production and good quality printing, the art work must be right.

Therefore, we have been forced to write detailed specifications for the preparation of art work which will cover most of the problems encountered. When followed, we experience very little trouble.

ORIGINAL ENGRAVINGS AND PATTERN PLATES

For long-run production items, many carton suppliers are required. Therefore, it is impractical to furnish art work to each supplier. This makes it necessary to furnish them with original engravings.

And right there we get into trouble. Original engravings which are satisfactory for use by one printer may be rejected by a second. If it were possible to obtain universally acceptable original engravings, many of our problems would be solved. Therefore, whenever possible, we transfer this responsibility to our supplier by sending the art work to him.

Due to limitations, we are required to order many of the original engravings used in producing our paper and board packaging materials. Therefore, in cooperation with our suppliers, we have developed our own set of written specifications.

E. H. Balkema, General Purchasing Agent, Colgate-Palmolive-Peet Co., Jersey City, N. J.

The Chicago Section April meeting group

These specifications are very detailed and are furnished to each of our engravers and converters. They are demonstrating their value in improved quality.

PURCHASING SPECIFICATIONS

We have written specifications for each item we purchase. We believe that these are a great help to our suppliers in guiding them along the quality control highway which we want them to travel. They are our way of telling our suppliers the limits which are acceptable to us.

Let us review those items on a purchasing specification which are of interest to the producer of the packaging materials.

1. The symbol or identifying number. This number is dashed up to one higher dash number each time a change is made in the appearance of the package which is visible to the eye.
2. The specification number. A new number is assigned each time any change is made in the specification. If the change is apparent to the eye, such as a change in design, then both the symbol dash number and the specification number are changed. However, if the change is not apparent to the eye, such as a change in a test procedure, then only the specification number is changed.
3. The specification number which is superseded. This number is most important as it permits the supplier to check the specifications and to determine that a record of all the changes in the package has been furnished to him.
4. The title or name of the item.
5. The drawing number for the art work.
6. The drawing number for the mechanical drawing.
7. The size.
8. The stock specifications and the allowable variances.
9. The colors.
10. The style.
11. The grain direction of the carton.
12. The identification markings that are to appear on the printed cartons.
13. How to prebreak the scorelines.
14. How to set the perforating score rules.
15. The tests which the carton *must* pass and the Laboratory Practice Instruction number for the test procedures used in making and interpreting the tests. These tests should be performed by the supplier before he ships the cartons, for we will test these cartons in our own laboratory before accepting the delivery for use on our packaging machines.
16. The reason for the latest change.
17. How to pack the cartons for delivery.

MECHANICAL DRAWINGS

All mechanical drawings are, when required, a part of the purchasing specifications. They are kept up to date at all times. It is by this procedure that we tell our suppliers what we want. They are used in preparing die-cutting forms and in checking the printed items.

STANDARD COLOR CHARTS

The purchasing specification under the heading of "color" says that the carton is to be printed "as per approved color sample." These approved color samples are what we call our standard color charts. Here again we believe we are cooperating actively with our suppliers in their quality control programs. The dark and light color limits definitely determine the width of the quality highway which is acceptable to us. It is the duty of our suppliers to stay on that highway.

It is very important that the part of the packaging materials, which the public sees, should be of a consistent color, regardless of the number of suppliers producing the materials. Color is as important as the trade name and it carries with it an indication of the quality of the product.

It is not enough to have visual samples of the desired color with its acceptable dark and light limits. These visual colors will fade, drift, or burn out with time and thus result in another color. For pastel colors, this change frequently occurs within a few months.

We use the G.E. spectrophotometer to show in chart form the exact color approved by our management, including its light and dark limits. These charts can be used to check the color of the visual samples. When the latter needs replacing, the same charts are used to determine if the new visual samples are the same as the previous ones at the time they were approved.

E. H. Balkema

Color is a complicated problem and requires a considerable expenditure of time and money. It is, however, good economy to maintain the same color for a particular product in order to permit the finished package to carry its story of consistency to the consumer and act as its own sales agent.

Therefore, we, like many other users of paper packaging materials, are forced to set up for our suppliers the quality control highway which they must follow.

About 2 months ago, I was in Mexico on packaging problems and was discussing color control with the managment of a printing plant. The managing director told me this story:

For some years they had been running a carton to house three candles which was printed with blue ink on white patent-coated stock. The production orders were written and issued in their regular manner. This time, the pressman looked at the attached sample and decided it should not be printed with blue ink but with red ink. So he printed it with red ink.

The mistake was discovered when the die-cut blanks reached the folding and gluing machine. Then the checking started. The pressman still maintained that the carton should be printed with red ink—not blue.

Management saw a complete loss, but took a chance and discussed the red printed carton with the buyer and explained how the mistake had occurred.

The buyer did not seem a bit interested in the reason for the mistake, but upon viewing the printed carton said, "You know, that pressman is right—it does look a lot better—I like it."

That kind of buyer is very hard to find in the States.

STANDARD PRACTICE INSTRUCTIONS

In discussing the subject of purchasing specifications, we mentioned the subject of standard practice instructions for making the tests on the carton.

Let us look at the product rub test. Here again the limits shown on the purchasing specification of "very slight smudging or bleeding of inks allowable" when conducted as described in this test procedure, establishes the quality control highway for our suppliers.

STUDIES IN PROCESS

In my opening remarks, quality control was defined as "keeping within limits of proper and essential being." You will note that we, in cooperation with our suppliers, have tried consistently to set fair workable limits of quality and to see that these in turn are used by our suppliers as their quality control highway.

If the producers of paper and board packaging materials could promote this or a better system with their customers, it would result in better customer-supplier relationships.

Some work along this line has already been started by the Packaging Institute. This work is being done by representatives of the manufacturers of paper, paperboard, glue, ink, labels, cartons, folding boxes, etc., in cooperation with the buyers and users of these items.

Some of the more important papers discussed at its last annual meeting which are of interest to the producers and users of printed paper packaging materials were as follows:

1. "Evaluating Resistance of Ink on Printed Packaging Materials to the Product in the Package," by L. K. Burnett of the Ohio Boxboard Co.

2. "A Better Name for Aniline Printing," by John Cozza of Cello-Masters, Inc.
3. "Testing Fading of Printed Packaging Materials by the Fadeometer," by George Cramer of Sinclair & Valentine Co.
4. "Evaluating Printability of a Material," by B. A. Gaffney of the New Haven Pulp & Board Co.
5. "Brain Direction of Labels for Sheet-Fed and Roll-Fed Labeling," by Earl C. Lenz of Paisley Products, Inc.
6. "Should the Producer of a Printed Packaging Material Specify Its Storage Conditions and How It Should Be Handled for Delivery to the Packaging Line?" by W. A. McCrehan of the Lord Baltimore Press.
7. "First-in First-out Control of Printed Packaging Materials," by G. J. Myers of the Norwich Pharmacal Co.
8. "Evaluating Gloss of the Printed Package," by T. Rosevelt of the Sun Chemical Corp.
9. "Proper Ways to Handle and Store Printed Packaging Materials in the User's Plant," by C. C. Sutton of the General Foods Corp.
10. "Test for Effect of Alkali on Printed Packaging Materials," by A. H. Twardowicz of the Lord Baltimore Press.
11. "Evaluating the Resistance of Printing Inks to Dry Rub," by L. R. Ayers of the Robert Gair Co.

Some of these papers were progress reports while others were complete. One of the outstanding papers was presented by L. R. Ayers on "Evaluating the Resistance of Printing Inks to Dry Rub," which paper represented the cooperative efforts of a Joint Task Committee of three organizations. These were:

Folding Paper Box Association of America
National Association of Printing Ink Makers
Packaging Institute

The active members of this Joint Committee were:

Gordon Dalsemer—Lord Baltimore Press
Edward C. Berg—Ace Carton Co.
Frank W. Cray—Interchemical Corp., Printing Ink Div.
George L. Erickson—Braden Sulphin Ink Co.
L. R. Ayers—Robert Gair Co., Inc.
E. H. Balkema—Colgate-Palmolive-Peet Co.

The secretary was William D. Hall, Folding Paper Box Association of America.

Tests were run in Chicago by the representatives of the Folding Paper Box Association of America, in New York by the representatives of the National Association of Printing Ink Makers, and at Piermont, N. Y., by the Packaging Institute representatives.

All the test samples were then sent to New York City and studied by the Joint Task Committee. After thoroughly discussing the data available, it was the unanimous decision of the five active members present who voted by ballot that the Sutherland rub tester was superior to the other two included in this test for evaluating the rub resistance of folding cartons.

This represents a long step forward and, when the Standard Practice Instructions for conducting the test are completed, I forecast that this rub test will be one of the most used and most valuable tests available to us.

QUALITY CONTROL IN THE USER'S PLANT

To force the producers of packaging materials to keep their quality "within limits of proper and essential being," it is necessary that the buyers establish their own quality control departments. Each delivery from a supplier should be sampled and tested. It cannot be assumed that each supplier will use consistently only those materials which will pass the tests and also that his conversion operations will always meet the specifications. Even with the best of quality control systems within the producers' plants, they still make plenty of mistakes. And some of these mistakes are very bad.

Typical samples observed within the last few months are:

1. Makeready sheets made into cartons.
2. Wrong color inks used in printing.
3. Incomplete die cutting of carton flaps.
4. Side seams of cartons not completely glued.
5. Side seams of cartons with so much glue as to make them impossible to open
6. Board stock with such a weak back liner that the cartons split open on the production equipment.
7. Off caliper and weight of board stock being used for an entire run.

There are many others with which most of you are familiar.

We detect most of these mistakes in our quality control department through a sampling system which has demonstrated itself to be about 90% efficient. The other mistakes that are found are detected on the packaging equipment.

In handling some of these complaints, we call for and receive the suppliers' statistical quality control charts. We use them as a guide in determining if we should use the materials in regular production or return them to the supplier.

As the cost of preparing these statistical quality control charts is included in the cost of the finished packaging materials, we consider them to be the property of the buyer. It is entirely possible that, at some future time, statistical quality control charts will be delivered by the supplier to the purchaser with each order purchased.

In our quality control department we perform on each delivery of packaging materials received the tests shown on the specifications. These are the same tests which we expect the converter to make before delivering the materials to us.

For a synthetic detergent, these tests are:

1. Fadeometer Test—No fade of inks in 24 standard hr.—SPI no. 5521.
2. Bleeding of Inks Test—Very slight bleed allowable—SPI no. 5525.
3. Product Rub Test—Very slight smudging or bleeding of inks allowable—SPI no. 5519.
4. Glue Lap Test —SPI no. 5532.

We are strong believers in "keeping within limits of proper and essential being" in the production of our own products. Yes, we also use the quality control highway charts at our production machines. Therefore, we like to see our suppliers do the same, although we do not insist upon it at present. It is interesting to note, however, that the annual billing volume is increasing for those suppliers who have a good effective quality control system. Those with poor or ineffective systems suffer by comparison.

Just one word of warning on this quality control business. No converters have produced yet and no buyers have received yet a 100% perfect job on volume production of packaging materials. At least I have not seen it. Therefore, we must not lose sight of the definition as "being within limits of proper and essential being."

GENERAL

In this discussion, I have stated that the buyers of paper and board packaging materials need help from their suppliers and that the suppliers need help from their national associations. Some examples have been given as to what one buyer is doing. He needs help also.

This is quite a job. We, that is, all of us working with or within the packaging industry, are faced with this problem.

It might even be called an operation "bootstrap" to catch up on what we don't know about the things we have, while at the same time we assimilate the latest developments.

The education of quality control men in the packaging field is on a pay-as-you-go basis. We are not fed annually with a new group of technically trained men familiar with the broad rudiments in this field.

Each year, collectively, we must retell the basic story of paper, board, inks, and their conversion into packaging materials and how to "keep them within limits of proper and essential being." To do this, we need more and more measuring sticks even though these standards change while we undertake to establish them.

Too many times during the past year we have asked ourselves the same questions we asked the year before—and provided answers based on guesses:

1. Will it look faded, scuffed, rubbed when we see it on the shelf?
2. Will we have excessive breakage or damage? (Incidentally, just what is excessive?)
3. Will the product lump—sour—lose potency?
4. Will the label fall off—get dog-eared?
5. Will the carton sag, get pot-bellied or look tired—part at the glue lap?
6. What important specification factor did we overlook this time?
7. Is the guy who is asking me to develop a new moisture barrier a crackpot or a prophet?

These questions and others are all of vital interest to both the producers and users of packaging materials. And, at the same time, they are a part of quality control—a part that, to date, has not been given enough consideration by the producers of these packaging materials.

Possibly we will have to look to organizations made up of technical people representing both the users and producers for developments in this phase of the quality control problem.

Lake Erie

The April 17 meeting of the Lake Erie Section was held at the Hotel Carter, Cleveland, Ohio, with about 45 individuals present.

Ralph H. Schwarz, President of the Ace Electrotype Co., Cleveland, Ohio, presented a paper on "Printing Plates for Today's Production Demands."

Mr. Schwarz' paper follows:

Printing Plates for Today's Production Demands

Ralph H. Schwarz

Today's pace in printing production is swift—the demand is for more speed, improved quality with color and register control. Added to this is the necessity to hold production cost down. To help solve the speed and cost problems, converters are using more rotary presses. While this type of equipment theoretically, at least, answers the demand for more and faster production at lower cost per impression, it places a great penalty on press down time. This has put new and added responsibilities on paper, ink, roller, and plate makers. Without coordination of the efforts of all these suppliers, the end result is not satisfactory—the goal is not reached. It is the plate maker's part in today's paper converting production demands that I want to especially discuss with you.

A monograph would not adequately cover the subject. A discussion of printing plates for today's production demands would not be complete if it did not include electrotypes, rubber printing plates, plastic plates, and the important beginning of all letterpress or flexographic printing plates, namely art work, engraving, and typography. Dry-offset plates should also be included since considerable interest is being shown in this method of printing.

Because our organization produces all phases of this work from the idea to the final printing plates under one management with undivided responsibility for performance, we can discuss the various kinds of plates without prejudice or bias.

Satisfactory results are more likely to be achieved if the beginning is made under the most favorable conditions. Art, black and white or color, is the starting point of most printed jobs in the paper converting industry. It is surprising how often the art furnished is not only unsuitable for the job to be done—it is too often not even correctly drawn, not properly squared and accurate as to the positions of the different panels or sections in relation to scores or folds. Art work for this industry is a specialty and unless the artist is completely familar with the production problems his work may be unsatisfactory regardless of how good an artist he may be. The placing of guide lines for color separation, register marks for checking, correct proportion of lettering and design are essential to a good finished product.

Typography is closely allied to art work. The selection of type to harmonize with the design in proper proportion to not only look well but reproduce well when photoengraved—with no filled-in letters and broken serifs, is essential. Reproduction proofs that are properly made to give clean sharp engravings are absolutely required. Type that is never used for any other purpose than reproduction proofing is an absolute necessity. Artists and typographers serving this industry must be specialists in this type of work if the best results are to be obtained. Any comments on typography would not be complete unless photocomposing were included. With so much type being etched, this method of typesetting will find a place in our industry.

Any photoengravers worthy of the name can produce plates that will print fairly well for the average run of printing. However, average photoengravings are not suitable for the printing requirements of the paper converting industry. They must be carefully handled from start to finish with complete understanding of the industry's needs. Not one extra step can be overlooked or eliminated to assure originals that will produce the kind of duplicate plates required.

It is evident that the closest cooperation between the artist, typographer, photoengraver, and duplicate plate maker is necessary to obtain maximum quality. It has been our experience that the best results are secured when a complete analysis of a job is made through a conference between the plate buyer and his plate maker at the inception of any job.

Considerable printing in the paper converting field is produced on flat bed presses, especially in the folding box division of the industry. Flat beveled nickel electrotypes are the plates most frequently used. The plate makers alert to the requirement of this production are using the sheet molding materials such as Vinylite, Tenaplate, and Tenamold as well as the time-tested and proved sheet lead for color process and accurate register work. A considerable advance has been made in plating solutions. The new nickel sulphamate solution produces a dense tough shell that withstands impression shock better than any other shell, including chromium. Copper fluoborate solutions, a comparative newcomer in plate making, produce shells that can be plated more quickly and evenly. The shell tinning process has been improved and speeded up by plating the tin instead of melting sheet foil on the back of the shell as usually practiced. The tin plating method has practically eliminated the occurrence of "soft face" which is not usually discovered until the plate is under the printing pressure of the press. The introduction of the Hydrocaster or similar methods for flat plate casting has so improved this operation that the "pounding" of electros in the finishing process has been generally eliminated. These are the principal improvements in the making of electros for flat bed presses. Many minor changes have occurred in flat plate manufacture, not in themselves revolutionary, but they all add up to better plates made in quicker time.

Probably the greatest improvement in electrotyping is in the production of rotary press printing plates. The new centrifugal curved cast or CC method can be called revolutionary. The all-important start of the plate is with the shell which is plated in the curved position. Curved cases formed to the radius of the press cylinder hold the mold in the proper curvature while the nickel and copper are being deposited. Thus the proper curve is started from this point to be "built" into the plate. In this first vital operation a precision curved cast or CC rotary press plate starts to differ completely from previous conventional methods of making

Ralph H. Schwarz, President, Ace Electrotype Co. and Associated Companies, Cleveland, Ohio.

curved plates. The shells are carefully checked throughout the plating operations to insure even thickness. Here the new plating methods previously mentioned assist in obtaining the desired result. Plating the shell curved permits more accurate performance of the curved plate operations to follow and assures better color registration. The tin is plated on the back of the shell in the curved position assuring proper bonding of the copper shell to the alloy backing metal.

After the shells have been stripped from the curved molds they are trimmed on a specially designed machine and the edges squared. The individual shells are then joined with another special unit of equipment into a complete 360° circle. Proper alignment of the shells with respect to their center line of curvature must be and is accurately maintained. While this operation is under constant control, volume production is obtained.

Next is the placing of the accurately joined circle of shells into the casting drum. They are so joined together that they fit snugly against the inside wall of the drum. The inside of this drum has been polished to a mirror surface to assure perfection in the finished plate. Different sizes of casting drums are required to produce plates for various press cylinder diameters.

The next step casts and curves the rotary plates in a single operation. The casting drum is rotated centrifugally at approximately 800 r.p.m. The backing metal is introduced with a special ladle while the drum is revolving. Centrifugal pressure forces the molten metal against the shell's inside or bottom surface until the metal cools and solidifies. The shell has become an accurate, precision curved cast and is then removed from the drum. During the centrifugal spinning, a number of revolutionary developments are taking place. Centrifugal force is casting and curving the plates in one operation—the force of the metal in the spinning action is correcting uneven printing areas in the plates and setting the metal into a compact close-grained mass. Register is actually built into the plates. A direct result of the plates non-stretch-no distortion characteristics is a minimum of press time makeready. Distortion results from the different coefficients of expansion and contraction of the backing metal and shell when a conventional flat plate is curved in the usual or cold-rolled method of rotary plate making. CC cast plates fit press cylinders more accurately than any rotary plates made by any other process.

The centrifugal action used in making CC plates has a desirable and refining effect on the backing metal. Many plates have been tested for fidelity, register, soft face, proper bond, and fatigue or commonly called cracking.

In connection with the tests conducted, the results of the metallurgical examination are of especial interest. It is a well-known fact that all metals, after cooling from the molten state, have a characteristic grain structure, and that the performance of the metal or alloy in service is affected to a large extent by the grain structure. One of the principal causes of failure in metal machine parts or pieces is from fatigue which is generally construed to mean the failure of a material after repeated application of a load that the material would easily carry in one application. A load is applied on a high-speed rotary press each time the printing plate contacts the paper. This load is released as the plate passes over the paper and for the balance of the revolution of the cylinder, the plate has no load other than the centrifugal force created by the rapid rotation of the cylinder. Incidentally this force is not to be considered lightly. However, the alternate compression loading of the plate while printing, and the tension loading while the plate is subject to centrifugal force, creates opposite stresses in the printing plate, and is an excellent opportunity or source for fatigue failures.

Innumerable tests in many different industries have demonstrated that coarse grain metals have low resistance to impact and consequently are subject to premature failure from fatigue.

In centrifugal pressure casting of electrotype plates, numerous metallographic examinations have shown the grain size to be inherently finer than the grain size of the flat or static cast plate. This is clearly evident in the photomicrographs at a magnification of 50 diameters. Fatigue tests have verified the belief that the centrifugally cast plates are superior because of their finer grain size. By variations in the cooling rate, brought about by slight changes in speed, drum temperatures, etc., this grain size can be controlled to a great extent. Another desirable feature of the centrifugally cast plate is the uniform disbursement of the lead-tin-antimony mixture, or more properly called the eutectic mixture. In the photomicrographs this is represented by the lines appearing as grain boundaries. Dross or other impurities which may accidentally be present in the metal are forced to the back of the casting by the centrifugal force in the new plate, where they are removed in the shaving operation.

Inclusions, voids, or any discontinuity in the structure of a metal subjected to intermittent loading, readily become the nucleus of a series of small cracks, which propagate from the inclusion or void through the metal structure, with subsequent failure of the piece. Propagation of such cracks is more rapid through a coarse-grained metal than through a finer grained metal, such as is produced in the centrifugal pressure cast printing plate. Plate fatigue or cracking due to faulty casting has, therefore, been practically eliminated in CC plates.

After the casting operation the circle or cylinders of plates are cut into the individual plate segments. They are then placed on a specially built shaving machine that both levels and takes a preliminary shave from the back of the plate. This is accomplished without stretching or creating misregistration or hard halftone edges. A proof of the plates is taken and any minor low spots or dimples are finished out. No beating or rough treatment is required to enable CC plates to produce clean level impressions. A final shave is taken to an accuracy of 0.0075 in. and the plate is then routed and beveled and is ready to go into immediate printing production on reaching the pressroom. The entire procedure has had a minimum of manual effort resulting in a rotary printing plate that is the most accurate reproduction of the original material obtainable by any process. The resultant plates shorten press down time, give longer plate life, require a minimum of makeready, and generally add to improved quality of the printed product.

I am going to give you a preview of the rotary press electrotype of the future.

Plastic plates have been recently introduced to the graphic arts industries. We made our first plastic plates about 11 years ago. Since that time the principal improvements made have been in the selling technique. They have, in many instances, been offered as the answer to all the problems posed in the use of other printing plates. One of the main difficulties encountered in the manufacture and use is that the vagaries of plastic materials make it almost impossible to produce plates consistently that will hold size and register accurately. They are at present used principally in the distribution of advertising material in newspapers and for the printing of text matter, in the book industry. Their advantages are lightness and speed in manufacture. The disadvantages are dimensional instability, the inability to patch or tool changes or corrections as in metal plates, a printing surface that is somewhat inferior to metal plates, a loss of faithful reproduction particularly in screens and fine lines. Further research and experimentation may overcome some of these disadvantages. We plate makers are not going to discontinue exploring their possibilities.

Rubber plates, both molded and hand engraved, have had long use in the paper converting industry. Some improvement has been made in hand engraved rubber plate making. The rubber itself has undergone several changes with the advent of synthetic rubber. The engraving technique has

been speeded up for certain kinds of work by the use of negatives and prints on the rubber as guides for the hand engraver.

Molded rubber plates are used principally in the envelope, paper bag, cellophane, polyethylene bag fields, and for corrugated container, paper specialty, and textile printing. The advances made in their production have been considerable. The molding materials have been improved and quality of rubber so improved as to lengthen rubber plate life considerably. Production techniques have likewise advanced so that now molded rubber printing plates can be made as accurately as metal plates. They can be supplied in many forms for easy attachment to most printing presses.

The fact is, the average molded rubber plate is a better product than many of the presses on which it is used. Molded rubber plates made to an accuracy of plus or minus 0.001 in. are being used on inaccurate presses and expected to make up for the press errors because of their flexibility. The results, of course, are not satisfactory but the plates get the blame when it properly belongs to the printing equipment. This condition is much more prevalent in rubber plate than in metal plate printing.

The inherent quality of a molded rubber plate to take ink and transfer it smoothly to most materials has no equal. Course screen halftone printing up to 85 line can be done. Four-color process work using coarse screens is being printed regularly, but—and I must stress this point—on accurate well-constructed printing presses built for this type of work.

Dry offset, high etch offset, or relief offset, three names commonly used for the process are suddenly receiving considerable attention and developing rather rapidly. This is not an entirely new method. It has been used for a number of years by concerns in the form printing field and primarily for black and white work. Development of the process for general commercial printing is already emerging from the experimental stage.

We are one of the few photoengravers who sometime back, sensing the possibilities of the process, began experiments in photoengraving relief offset plates. We do not pose as experts in this field but we are learning fast and are now supplying plates that are producing good results.

The advantages inherent in dry relief offset are many. There is almost no makeready which adds considerably to press running time. Relief offset plates can be re-etched and finished or otherwise corrected while in so-called wet offset all the work must be done in the negative or positive. You can print on most any kind of stock that is typical of offset. Also you have a process that letterpress pressmen can learn quickly because it does not involve the chemical mystery, the gumming up of plates, and the scientific control of ink and water balance that goes with regular offset.

We are presently supplying plates for two different makes of presses. It is our understanding that other press manufacturers have this type of press under consideration or on the drawing boards.

High relief or dry offset will surely find its place in your industry.

Pre-makeready should be included in any discussion of printing plates. The methods most commonly used are the Claybourne, Vandercook, and Bishop-Stansell methods. The first two mentioned are primarily concerned with pre-makeready of forms and originals used in making duplicate plates or printing directly from the type and originals. The Bishop-Stansell method is designed to incorporate pre-makeready in the finished electrotypes. This consists of cutting overlays and underlays in specially prepared matrix material, attaching the cut-out sheets to the face and back of the plates, and passing the assembly through a specially built press that incorporates the predetermined high and low areas where desired in the plate.

Pre-makeready is incorporated in molded rubber plates by underlying the matrix or by overlaying the areas to be lowered while the plate is passing through a grinding or leveling machine.

The amount of makeready desired is so controversial that no standards can be established. This can only be determined through trial at each plant and an understanding of each pressman's desires.

It is still the thinking of many authorities on printing pressures, that a plate of accurate thickness, attached to a mechanically accurate printing press, will produce the best impressions.

I believe we agree that printing plates are vitally important to the paper converting industry. Actually without them the mass production of your product would be impossible and yet we plate makers are rarely asked to contribute our experience to equipment manufacturers or consulted by suppliers of other materials that go into the finished product, until something has gone wrong.

The printing plates are usually blamed for poor printing results making it necessary for the plate maker to prove his product or that the fault does not rest with him. Surprisingly, in most cases the trouble is found to be other than plate problems.

So much could be accomplished for today's production demands if all suppliers and converters cooperated more closely to prevent the problems that cause delays instead of waiting until they occur.

I have tried to tell you about the new methods and production aids that have entered plate making. Many are already in everyday use, others are in the experimental stage but show considerable promise. They are all designed to help meet today's production demands.

Q. Can maximum or minimum pre-makeready be put into plates?

A. Pre-makeready can be put in up to 7 to 8 thousandths. If variation is too much a beveling effect occurs—that is, it may run over from darker to lighter areas.

Q. In centrifugal casting, does the shrinkage of the metal affect the register?

A. The plates will be somewhat smaller but they will all shrink the same, giving the same register.

Q. Would the register be more accurate for centrifugal casting plates than stretch plates?

A. Yes.

Q. If a flat plate with small type requires 7 to 8 thousandths, why shouldn't centrifugal casting plates also?

A. All I can say is that the improvements from centrifugal casting I have seen are revolutionary. A lot will depend on the nature of the design.

Q. Is the lack of dimensional stability in plastic plates due to their temperature while being run?

A. It is not only due to that but also the manufacturer cannot exactly duplicate from one supply of plates to another. Much more work has to be done yet in this field of plastic printing plates.

Q. Does the quality of paper enter into the results given by printing plates?

A. Generally speaking, the paper affects the results more with rubber plates than with other types.

J. W. Means, *Recorder*

Eighth Engineering Conference

Technical Association of the Pulp and Paper Industry

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Developments in the Graphic Arts—1952

R. H. SIMMONS

This issue of Developments in the Graphic Arts, as has been mentioned in previous years, is obtained mostly from the literature. The author has been fortunate, in some cases, to have had direct information relative to some of the items but, since they have all been published within the year, this information has not been of help in preparing this article other than to temper the report.

During the past year there have been many articles relating to determining the printing quality of paper. It was originally planned to include these methods under a separate heading but too many items of interest as actual developments crowded this work out.

No bibliography has been included this year. It is hoped that sufficient information has been included in the body of the article to permit the reader to obtain the source of the development.

PAPER

The Munising Paper Co. (Chicago, Ill.) is manufacturing a product composed of fiber and plastic which gives excellent printing results with process inks by both the letterpress and litho process. The material is tough, durable, has a high tear, lies flat, and will not flake or fray at the edges. The material can be cleaned with a damp cloth and mild soap.

Champion Paper & Fiber Co. has added two-sided Kromekote to their line of papers.

The U. S. National Bureau of Standards has made a paper which is composed entirely of glass fibers with no additives. The raw material was commercially available fine glass fibers. A 1% consistency in water was found to give the best results with a short beating time. Paper strength depends on assorted fiber lengths. The paper has been suggested for use in filters for gas masks and as an insulator and dielectric.

The Carborundum Co. (Niagara Falls, N. Y.) has developed a ceramic fiber "Fiberfrax" which will resist 2300°F.

In the instrument field, we have a glossmeter invented by Kenneth Bowers and Thomas E. Mason (U. S. pat. 2,578,625 (Dec. 11, 1951)) assigned to the Glens Falls Laboratory, Inc., which is adapted to the continuous measurement of gloss on a running web of paper immediately after the web leaves the calender stack. The meter is capable of comparing the gloss of the paper with a standard of known reflectivity.

The American Instrument Co. (Silver Spring, Md.) has an expansion and contraction meter which consists of a turntable which holds ten 3 by 10-in. specimens in a humidity chamber. Outside the chamber are two filar microscopes mounted on an invar plate. Each microscope is focused on each specimen. Measurements are accurate to 0.0002 in.

The Gilbert Paper Co. (Menasha, Wis.) has installed a BG-1 Beta Ray Gauge to check weight and density of paper. The gage is a C frame mounted after the last drying roll on the paper machine. On one tip is the radioactive material and on the other a detector head. By measuring the amount the ray diminishes on passing through the paper, a continuous reading, accurate to $^1/_2$ of 1%, is obtained on the weight of the paper.

Neel Martinet (U. S. pat. 2,568,199 (Sept. 18, 1951)) has an instrument for testing ink penetration whereby the sample is placed between two electrodes which are inserted in a measuring circuit and the sample brought in contact with the ink under given conditions of pressure and temperature. The time required for the current to reach a given value under constant voltage constitutes the test.

Phillip Jenkins of the Columbus Banknote Co. has invented the "Rollaskid," a mechanism which permits turning over an entire skid of paper, in about 8 min. The device eliminates the development of ragged edges, creases, fingerprints, and smears due to handling. M. L. Abrams of Cleveland, Ohio, is building these devices.

Olssen and Pihl (*Svensk Paperstidn.* 55, No. 7: 233–237 (April 15, 1952)) have found that the oil flotation method for oil absorption shows lower values than the height of rise test. The grain of the paper has some effect on the results. The finest pores in the paper did not affect the results by the floatation method, but were noticeable in the oil rise.

J. Villars (*Papeterie* 74, No. 4: 213, 215 (April, 1952)) has found that the pH of a stock suspension in the headbox (I) is lower than that of the water below the wire. The cold extraction method gives results 0.6 to 1.6 pH too high. The hot extraction is nearly the same as that at (I) but is erratic. A suggested standard for l'ATIP which gives results which agree fairly regularly with (I) is to cut a 1-gram sample into 1-mm. squares, moisten with 20 ml. of water and 50 ml. of sodium hydroxide plus 5 grams sodium chloride. Shake and let stand 1 hr. at 20°C. Measure the pH in the unfiltered suspension. Results are reproducible within 0.1 pH.

Barret K. Green (U. S. pat. 2,581,186 Jan. 1, 1952; Can. pat. 473,636) recommends a paper coated with zeolite materials as an improved printing paper. The zeolite has internal channels which act to absorb ink fluids.

Stilbert and Clack (*Tappi* 34, No. 8: 337–347 (Aug., 1951)) report on the properties of vinyl chloride–vinylidene chloride latex for paper coating. Dow Latex 744-B is this material.

The Packaging Institute has advanced three proposed tests for printing packaging materials: "Proposed Test for Effect of Alkali on Various Types of Printed Packaging Materials," "Proposed Method of

GAM—Graphic Art Monthly.
GAF—Grafiska Forskninglaboritoriet Medd.

R. H. Simmons, Chemist, U. S. Government Printing Office, Washington, D. C.

Testing Packaging Materials for Fastness to Light by Use of the Fade-Ometer," and "Testing Resistance of Ink on Printed Packaging Materials to the Product in the Package." The methods in detail are published in *Modern Lithography* for March, 1952, pages 38–40.

"Lithowipes," a disposable plate processing towel manufactured by Kimberly Clark Corp., permits the use of a clean wipe in each step of the platemaking process so that there is no mixing of solutions.

PRINTING INKS AND SUPPLIES

Coates Bros., Ltd., London, are making a pressure setting ink called "Nonox" in a black which sets in under 2 min. on coated papers and 2 to 10 min. on uncoated papers. A similar ink is made in Germany under the name of "Prestoprint." The latter inks are not for use on parchment, foil, glassine, and dry slowly on hard-sized papers.

British pat. 654,535 (1951) is for emulsion printing inks. The patent recommends a long-chain, nonaromatic amine containing a linear hydrocarbon chain of at least 15 carbon atoms and at least 18 carbon atoms attached to nitrogen atom carbon bonds (octadecylamine, 1-hydroxyethyl-2-heptadecyl imidazoline or octadecyldimethylamine) as emulsifying agents.

American Resinous Chemicals Corp. (Peabody, Mass.) has a series of pigmented vinyl inks named "Vinosol" which are flexible, waterproof, abrasion, fire, and chemical resistant. These inks are applied by rotogravure, striping boxes, spray gun, knife, or reverse roll coater. A short baking period of 45 to 60 sec. at 340 to 400°F. sets or fuses the coating. To improve the gloss a clear coating of Vinosol 71-43 should be applied by knife coating.

Extensive work has been carried on to obtain an ink which will print satisfactorily on polyethylene film and plastic. Interchemical Corp. uses the "Anilox" method which involves applying an anchoring coat to the film so that the ink will adhere during printing. The coating compound is believed to be a rubber base dissolved in an aliphatic hydrocarbon solvent. The inks, too, are rubber-based and firmly grip the anchoring surface. An aniline press equipped with buna rubber rollers can be used for the application of the anchor coat. The press runs at a speed of 200 f.p.m.

Visking Corp. (Chicago, Ill.) treats the film with chlorine before printing. To print on the resulting chlorinated polyethylene presumably requires alcohol inks.

Velveray Corp. (Clifton, N. J.) is thought to be passing the film over a hot roll (165 to 200°F.) just before printing with a cold roll to set the ink after printing.

Milprint, Inc. (Milwaukee, Wis) uses the "Perma-Process" preinking treatment with dibutyl phthalate, as a plasticizer to make the inks flexible and then overlaying the ink with varnish to protect it and also give it a gloss.

The Traver Corp. (Chicago, Ill.) uses the "Loxtite-Treated" method which is described as an electronic system which lines up the molecules. It takes about $^1/_2$ hr. to ready a roll of tubing for printing.

The production cost for polyethylene printing is higher than with normal printing due to this extra processing.

Australian Plastics 6, No. 64: 35–36 (1950) report that an ink consisting of a pigment mixture of polyethylene and polyisobutylene in a solvent consisting of tetrahydronaphthalene and trichloroethylene will print on polyethylene.

Merrill R. May (Sun Chemical Corp.): U. S. pat. 2,612,480 (Sept. 30, 1952) is a water in lacquer phase, the lacquer phase having pigment dispersed therein and a vehicle containing for approximately 20 to 30% by weight of binder composition approximately 6 to 14 parts by weight of polyethylene, 3 to 7 parts of paraffin wax, the ratio of polyethylene to wax being within a range of from 2 to 1, 4 to 1, or 4 to 10 parts of a material selected for the group consisting of natural rubber, polymerized 2-chlorobutadiene 1,3, polymerized 2,3 dimethyl butadiene, polymerized butadiene, a copolymer of isobylene and butadiene, a copolymer of butadiene and acrylonitrile and cyclized synthetic polyisoprene, the remainder of the vehicle comprising an aromatic hydrocarbon solvent.

The Reiger Printing Ink Co. (Toronto, Canada) has odorless inks in black and color, gloss and flat for food wraps, cartons, and labels for printing by letterpress and offset. Wolfgang Fuhler in *Allgem. Papier-Rundschau* No. 18: 815–17, Sept. 26, 1952 (German), discusses the different possibilities for the formation of objectionable odors in printed packages which may be traced to either the paper, board, adhesives, printing inks, lacquers, vehicles, driers, antioffset sprays, or the incorrect combination of some of the same. He recommends that the printer should be informed when odorless printing is required so that he can make the proper selection of materials.

The Research Institute of the Engraved Stationery Manufacturers Association has instituted a program at Battelle Memorial Institute (Columbus, Ohio) to study inks formulated for use in steel die stamping.

The United Printing Ink Laboratories, Inc. (Philadelphia, Pa.) have introduced high-speed metallic inks. They are nontarnishing, single impression preoxidized inks, available in rich gold, pale gold, rich pale gold, and silver. They can be supplied in the varnish form or in powder and are effective on all kinds of paper from boxboard to cellophane. There are also twelve colors of flexible high-speed inks.

McCutcheon Bros. & Quality (Philadelphia, Pa.) have a new line of inks, "Lightnin Set" offset inks, in black and process which set almost instantly on virtually any kind of stock.

Paul W. Greubel has assigned to the American Can Co., several patents, 2,597,863 (May 27, 1952); 2,597,864 (May 27, 1952); and 2,602,072 (July 1, 1952) which deal with a finishing varnish for application to wet lithographic printing. Considerable detail is given for the manufacture of these varnishes in the patents. Peerless Printing Ink Co. (Philadelphia, Pa.) is selling a series of dispersions of various grades of carbon black in printing ink vehicles including linseed, nonscratch rosin, and alkyd varnishes. The process is said to be different from the conventional methods and develops more strength for the same percentage of black.

INK MAKING MATERIALS

Rohm & Haas Co. (Philadelphia, Pa.) has a new acryloid resin B-82, a water-white, solid polymer of an acrylic type ester, good for coating, excellent clarity, durability, chemical resistance, and low pigment reac-

tivity. The resin is 100% solids with a softening range of 70 to 80°C., and flows at 140 to 155°C. A 40% solution of toluol has a viscosity of 400 to 700 cp. This company also has a new alkyd modified triazine formaldehyde resin, "Uformite M-311" which imparts high gloss, fast curing speed, high soap, alkali, hot water and humidity resistance, said to be 60% nitrogenous resin and 40% alkyd resin.

Baker Castor Oil Co. (New York, N. Y.) has gone into volume production on propylene glycol monoricinoleate, a derivative of castor oil. Its name is "Flexricin 9" and it is to be used as an allyl starch plasticizer. Flexricin 10 is a modification of this ester.

Nordgren, Baker & Champlin, in the *Paint, Oil & Chemical Review* 114, No. 2 (1951) discuss the new allyl starch vehicles. In their article, allyl starch is classed as a polymerizing resin which dries rapidly from solution by the release of solvent. The film tends to shrink and should be plasticized with from 10 to 30% plasticizer. The material is soluble in the alcohols, ketones, esters, halogenated hydrocarbons, nitroparaffins and most esters, pure dipropylene, or hexalene glycol. The material acts as a good vehicle for aluminum powders.

U. S. Industrial Chemicals have a new phenolic type ink resin, "Arochem 533." It can be used to make a pale, fast setting, hard drying, slow penetrating gloss varnish or a quick-set ink. Oil soluble in varnish, it cooks at about 400°F. to give a high viscosity oil varnish base. It is compatible with a wide range of drying oils, varnishes, alkyds, and ink solvents. The near gel structure lessens penetration and results in a scuff-resistant high-gloss vehicle.

Glidden Co. (Cleveland, Ohio) has developed a new Nelio Extra Dry Resin (NDX). The rosin is processed from native pine gum to remove residual traces of turpentine. The resulting rosin is very uniform and very high melting for this type product. Vacuum distillation, chemical control, and raw gum blending are responsible. For use where high softening or melting point and low ash are needed. The iron content is also low. The color is in grades, in N and M.

American Cyanamid Co. (New York, N. Y.) has been assigned U. S. pat. 2,576,094 (Nov. 27, 1951) for a noncrystallizing rosin made by heating rosin at 250 to 300°C with from 0.1 to 1.0% of phenothiazine for not less than 15 min.

Krumbhaar Chemicals, Inc. (South Kearney, N. J.) have a new nonheat-set, neutral synthetic resin (K-1717). It was designed for use in aniline inks. The resin is compatible with a number of film formers and its strong adhesive properties, good alkali resistance, and insolubility in petroleum thinners permit formulas highly resistant to such products as naphtha and gasoline.

Alfred F. Schmutzler has assigned to American Cyanamid Co., U. S. pat. 2,590,655 (March 25, 1952) for a tall oil ester. The patent is for preparing an acrylonitrile modified tall oil ester by esterifying tall oil with a saturated aliphatic polyhydric alcohol in the absence of an appreciable amount of any polycarboxylic acid and heat reacting the resulting product with 4 to 28% of monmeric acrylonitrile.

American Cyanamid Co. also reports pilot-plant quantities of triallyl cyanurate which is compatible with many other monomers and alkyd resins. Copolymerizations are carried out readily to give heat and chemical resistant resins.

A report from India abstracted in the *American Ink Maker* 30, No. 2: 49, Feb., 1952, states that Kamla seeds contain 40 to 80% of fixed drying oil. The seeds are from a small evergreen tree in tropical India. The oil is extracted by light boiling petroleum ether. The use of this oil has been patented and has been found to be superior to tung oil in various coatings.

A report in *USI Chemical News*, May, 1952, says that a gum type substance from larch trees may replace gum arabic. Arabogalactan can be produced completely from the trims, ends, slabs, and other larch tree waste products of the sawmill. The gum can be extracted chemically so that the waste can be used for pulp manufacture. The product is odorless, tasteless, and is instantly soluble.

D. Enkste in the *Polygraph*, pages 5, 7, 139, April 5, 1952, states that the Graphic Research Institute of Abyssinia has developed "Universal-Lipra I," from the sap of the babassa palm as an ink additive. The material is a light-fast, brilliant, colorless varnish. It has chemical and physical drying properties which do not produce specky gloss nor repulsion of overprinted inks. The thin ink film of a freshly printed ink resists any mechanical friction. The material produces intense, trouble-free saturated printing of flat tones, irrespective of the quality of the paper, without picking. The additive eliminates any alkaline reaction.

The Rollo-Graphic Corp. (New York, N. Y.) has Eezy Lith No. 10, an additive for offset and letterpress inks which eliminates picking and sticking on coated paper, prevents offset, overcomes tackiness in inks and blankets, increases rate of drying, and produces a free flowing consistency in the ink, adding to the ink coverage. The material will not change the shade of the ink nor harden the rollers or blanket.

Emery Industries (Cincinnati, Ohio) have a wax extender, "C-842-R Stearone." It is a white crystalline solid with a melting point of 75°C. It is insoluble in water and only slightly soluble in alcohol or ether. "Stearanilide A-805-R" is a hard odorless waxy solid which may be used in carbon coatings.

Warwick Wax Co., a subsidiary of Sun Chemical Co., is having produced by the Cooperative Refinery Association of Coffeyville, Kans., "Warcosine," a ceresine-type wax for use in paper products. It is obtained from the solvent extraction of selected crudes. The wax combines some characteristics of fully refined paraffin wax with the highest quality plastic micro waxes.

Central Compounding Co. (Chicago, Ill.) is marketing "Glazcote." This material blends with all types of inks, produces a hard finish on inks which will withstand scratching and marring during cutting, scoring, folding and gathering, as well as damage during stacking and in transit. The material will not produce chalking and does not separate or settle.

Raybo Chemical Co. (Cleveland, Ohio) has a suspension aid, "Raybo 6," which shows great influence on retarding the settling of pigments in dispersions where the solvent proportion is relatively high. The experimental work was done on solvent dispersions of styrene butadiene.

J. G. Curado, in *American Ink Maker* 30, No. 5: 29–31, 65, 67, May, 1952, has discussed the research in news ink. Research has been directed at the elimination of offset, strike-through, show-through, smut, and

misting. Curado discusses also the advantages and limitations of heat-set and steam-set inks and the use of ultraviolet, infrared light, supersonic vibrations, ultra-high frequency radio waves, and sulphur chloride for accelerating ink drying.

Gosta E. Carlsson, *Grafiska Forskninglaboratoriet Medd* No. 26: 46–50, May, 1951, studied the effect of printing newsprint with inks of different compositions. Three samples of newsprint from different paper mills were printed on a proof press with eight inks of different composition and the degree of blackness of the print and the strike-through were measured optically. No fundamental influence of the ink composition on the difference of the printing results between the three papers could be established. However, it was found that the inks which contained 12% carbon black caused considerably less strike-through and a somewhat higher degree of blackness than inks with only 10% black.

L. Pihl (same reference as Carlsson), reports that when boxboard is printed by offset, a weak image of the print, not caused by set-off, may appear on the back of the sheet, a so-called ghost printing. It was found that this image was caused by volatile fatty compounds in the ink, condensing on the back of the overlying sheet in the pile even when there is a space between the sheets. Driers, in particular, contain such volatile substances.

Harry H. Hull, in the *American Ink Maker* 29, No. 9: 33–35, 70, Sept. 1951, reports that ordinary frictional dissipation of energy is not consistent with the mechanics of filament formation in printing inks and that surface tension will hinder rather than promote their formation. It is also shown that the elastic properties of ink are important factors in determining filament formation between parting surfaces of the film and, therefore, viscoelasticity should be considered in studying the printing properties of an ink.

E. F. Kurth and Frank L. Chan (*J. Society of American Oil Chemists Association* 28, No. 10: 433–436 (Oct., 1951)) report that dihydroquercetin, a white crystalline pentahydroxyflavanone, which occurs in large quantities in Douglas-fir and Jeffrey pine barks, was found to be an effective antioxidant for lard, cottonseed oil, and butter. This compound imparts no taste or color to fats and oils and, like quercetin, appears to be nontoxic. Three hundredths per cent quercetin was found to be slightly more effective than the same amount of dihydroquercetin as an inhibitor. The presence of small amounts of citric acid increased the antioxidant effect of the dihydroquercetin.

INK DRYING

G. E. Carlsson and L. Pihl (*American Ink Maker* 30, No. 12: 38 (Dec., 1952)) have done considerable study on printing inks. In lithographic inks, it was found that emulsification tendencies of an ink were related to both the vehicle and the pigment. That for a given ink, when using an ammonia-phosphoric acid fountain solution, the drying time increased with the increase in pH. A negative ion in the fountain solution showed that the nitrate and chromate had the least effect but that the sulphate, primary phosphate, oxalate, and citrate slowed the drying time. With the nitrate, the ink dried in 4 hr., but took 77 hr. when citrate was used. It was found that the cobalt metal showed greater solubility in a phosphate fountain solution while manganese showed a greater solubility in the oxalate ion. Lead, cobalt, and manganese can be deposited on zinc from the fountain solutions after they have been extracted from the ink.

Advance Solvents and Chemical Corp. (New York, N. Y.) have "Zirco" drier catalyst, a zirconium chemical complex in mineral spirits of 6% zirconium strength. This drier exhibits synergistic qualities in combination with the regularly used metals. When used with cobalt drier, greater film hardness is obtained. The material is not affected by hydrogen sulphide and better color films are obtained when it is used as part of the drier content.

Meyercord Co. (Chicago, Ill.) supplies "Chem-dry" ink hardener. The method contacts the printed surface with sulphur dichloride vapor which combines with the oil and hardens the surface in a few seconds.

The *USI Chemical News* for July, 1952, reports that the use of sulphur dichloride may produce an addition reaction with drying and semidrying oils and a substitution reaction with nondrying oils. Copolymerization effects have also been suggested. It is stated that a cleaning step must be given to the material exposed to the sulphur chloride.

Alf Andersson and L. Pihl (*GAF* No. 28: 3–15 (Feb., 1952)) found that ink taken from the fountain and from rollers of an offset press contains 24 to 32% water and the drying time was considerably longer than for ink taken from the fountain. It was found that hydrolysis of the driers through the action of the fountain solution takes place. A calcium perborate drier was developed which has an exceedingly strong beneficial effect on inks emulsified with fountain solutions.

Advance Solvents & Chemical Corp. (New York, N. Y.) has "Soligen" rare earth naphthenate—4%, a catalyst used for promoting cross-linking polymerization at elevated temperatures. The drier is most interesting when used in whites because of its color retention compared to cobalt. The amount of the rare earth drier used can be greatly reduced in comparison to cobalt. An improved toughness of film is noticed and lack of discoloration at elevated temperatures.

Polygraph, 4: 18,634, 1951, reports on the drying of inks by ultraviolet light. A linseed oil containing 10% lead linoleate dries in the dark in about 15 days, in sunlight in 8 days, and in ultraviolet light in a matter of hours. The cost is low and no injurious effects on health have been found from ultraviolet light. Advantages for its use in tin printing have been demonstrated.

PATRA (*Paint Technology* 16, No. 192: 538 (1951) has shown that an irreversible adsorption of cobalt naphthenate from linseed oil solutions takes place on paper, depending upon the acidity of the paper, and that this may be a cause of the nondrying of some printing inks. Ammonium dihydrogen phosphate is one salt causing nondrying of inks. It is recommended that only gum arabic or carboxymethyl cellulose be used in the fountain solution.

A Japanese pat. 179,854 has been issued for a synthetic drying oil manufactured by combining 100 parts of acetone, 5000 parts of acetaldehyde in 15 parts of sodium hydroxide at 10°C. for 3 hr. which gives a top layer of a crude drying oil. The bottom layer is removed and the top layer heated at 70°C. for 6 hr. and then distilled to remove free solvents. The oil can be

mixed with carbon black to give an ink in proportions of 1000 parts of oil to 320 parts of black.

Alkydol Laboratories (Cicero, Ill.) have a grinding vehicle "S1190" for concentrated colors which has extraordinary pigment wetting properties. It is a low viscosity, high solids, alkyd resin solution with a wide range of compatibilities. It is easy grinding with no signs of livering or skinning after 6 months.

In the field of fluorescent colors, there are many new sources. Coates Bros., Ltd. (London, England) are producing yellow and green letterpress inks.

The Inco. Co. (Cleveland, Ohio) have "Inc-O-Lite" in yellow, orange, and green.

Shannon Luminous Materials Co. have "Hi-Brite" in yellow, orange, green, and cerise. Their inks are water soluble, work best on soft finished stock, and must be run with a wide open fountain and sometimes a double roll. These inks do not mix with regular inks and need a special solvent to wash up. They dry in 20 to 30 min. Radiant Color Co. (Oakland, Calif.) have a line of fluorescent inks called "Velva-Glo." Switzer Bros. (Cleveland, Ohio) have a new "Day-Glo" Rocket Red. This is comparable in color to conventional inks but many times brighter.

Minnesota Mining and Manufacturing Co. (St. Paul, Minn.) has the "Scotchlite" brand of reflective sheeting. Emblems can be printed in full color by letterpress. The new material is called "Flat-Top" and is a wide angle reflective sheeting which reflects even from curved areas. The inks are in opaque black, red, light red, blue, light blue, yellow, green, and gold. They are packaged in $^1/_2$-lb. cans.

OFFSET PROCESS

Minnesota Mining and Manufacturing Co. has a presensitized aluminum plate which is printed and developed, using a desensitizer, and is then ready to be attached to the press. The fountain solution washes the surplus desensitizer from the plate. These plates are designed to run better than 5000 impressions. This company also has a plate in sizes up to 22 by 34 in. The plate takes only approximately 5 min. to prepare. They are 0.006 in. thick. There is no oxidation and no stretch. The plates print up to 300-line screen in sharp, clear impressions in runs of between 20,000 and 45,000.

Polychrome Corp. (Yonkers, N. Y.) also has a presensitized aluminum plate which is coated on both sides and is called "Dualkote." One side of the plate is exposed, a desensitizer applied, and the image developed. The procedure is repeated on the opposite side and the plate preserved. Exposures take one-third less time than an albumin plate. Humidity does not affect the exposure. Additions and deletions can be made.

Standard Rate & Data Service, Inc. (Evanston, Ill.) has a direct image plate called "Lamitallic." It is an aluminum foil laminated with a water-resistant tag. The grain is sandblast finish. When the ink has set to the proper tackiness, the plate is coated with gum arabic and the ink washed out of the image areas with a suitable solvent. The plate is rolled to reposition the depressed printing. The results are similar to a deep etch plate.

A process for the production of a planographic plate, Stephen V. Worthen, U. S. pat. 2,534,650 (Dec. 1 1950); Can. pat. 475,217, (July 10, 1951) consists of treating a coating of a hydrophilic adhesive and a finely divided filler on a paper base with an aqueous ammoniacal solution of a bivalent metal salt-ammonia complex (e.g., cuprammonium chloride). Worthen also has Can. Pat. 475,218 (July 10, 1951) in which a wet strength paper is coated with 15 lb. of a dry weight of a coating composed of casein and clay in ammonia. The coating is dried, calendered, and then treated with a strongly ammoniacal solution in which 16% zinc chloride has been added. The sheet is again dried and, when properly prepared for printing, should produce 1000 prints.

Frost and Brinnick, U. S. pat. 2,574,258 (Nov. 6, 1951) assigned to S. D. Warren Paper Co., have a sensitizer for the preparation of photosensitive plates composed of an aqueous vehicle, a water-soluble hexavalent chromium compound of the chromate group, a liquid to semiliquid, unsaturated, organic, oily to fatty material capable of reacting with bichromate in the presence of actinic light to give a film and a water-soluble phosphate. The various materials are in the proper proportions to give a light-sensitive coating with a pH of from 3 to 9.

The Gevaert Photo-Production, N.V., British pat. 648, 897, have a plate made by coating a support with a photosensitive colloid which, when exposed, through a negative, is developed in a tanning solution such as pyrocatechol with a subsequent washing in warm water and then in dilute citric acid followed by a mixture of formaldehyde, pyrogallol, and potassium ferrocyanide, and finally with a gum arabic, cupric chloride solution. If the negative is replaced by a positive and the image reversed by developing in a nontanning developer followed by a uniform exposure and development in a tanning developer, a deep etch plate can be made.

The American Stencil Manufacturing Co. (Denver, Colo.) has the "Sure-Rite" direct image plate which is said to give trouble-free performance, outstanding dimensional stability, and complete freedom of scumming if the directions are followed implicitly. The directions are printed on each package.

Michael Bruno of the Lithographic Technical Foundation has a new grainless offset plate. LTF is working with an inkometer attached to the press to get readings directly on the press. They have also developed a new solution to prevent rollers from stripping.

Frederick H. Frost, U. S. pat. 2,562,782 (July 31, 1951), has developed the idea and suggests several methods of application where the offset blanket is water repellent and hence does not require as much water in the lithographic system and, therefore, does not transfer it to the paper. He suggests treating a rubber blanket with paraffin or a water shedding plasticized vinyl resin lacquer. An alternative is to prepare a blanket from a sheet or copolymer of 85% of vinylidene chloride and 15% vinyl chloride plasticized with 5% dibutyl sebacate, dibutyl phthalate, or diethyl phthalate or make the blanket from silicone rubber.

Paul J. Whyzmusis, U. S. pat. 2,572,228 (Oct. 23, 1951), has developed an etch for bi and trimetallic litho plates which will dissolve the chromium without attacking the copper base. The etch has a relatively slow action on the bichromated, light-hardened gum film. The etch consists of a concentrated solution of a chloride of calcium or magnesium with a minor propor-

tion of a concentrated solution of stannic or chromic chloride and sufficient acid to reduce the pH to below 2.0.

William A. Franges, Inc. (Jamaica, N. Y.) has a new line of "Metalife" chemicals for platemaking and press from which all toxic, poisonous, and corrosive ingredients have been eliminated. The plate coating material has very low sensitivity to climatic changes. The thin coating which can be applied creates a tough image and high fidelity.

The Foto-Flow Copying Machine is being carried by the Haloid Co. (Rochester, N. Y.). The use of this machine makes it possible to produce customer proofs without excessive charge.

The Monotype Corp., Ltd., has converted the monotype caster and substituted a camera for the caster to do phototypesetting. The Photon, Inc. (Boston, Mass.) successors to the Lithomat Corp. have the Photon Phototypesetter, while the Halber Corp. (Chicago, Ill.) has developed a desk model phototypesetter which is no larger than a portable typewriter. This small machine will produce composition from 18 to 144 points in most of the popular type faces. It operates by photo contact prints.

The Potter Instrument Co. (Great Neck, L. I.) has the "Flying Typewriter." The machine is operated by a magnetic tape prepared on a machine resembling an office typewriter which, when fed into the machine by means of photoelectric cells and vacuum tubes, converts the information into type at the rate of 5 lines per sec.

The American Type Founders are producing a new line of Chief offset presses with the plate cylinder undercut 0.030 in. to allow for the use of the thicker plate for dry offset. Extra packing is used to accommodate the standard plate. The plate rollers are dynamically and statically balanced and capped roller bearing sockets give greater precision control. The lead and trailing edge of the plate enters the gap with a less abrupt bend which permits the ink rollers to contact the plate without bumping. This lengthens the life of the plate.

Lind Hog Machinery Co. (*GAM*, April, 1952: 208) has a machine which cleans regrained offset plates by scrubbing both sides of the plate with high-speed rotary brushes and a forced flow of water. The plate then goes to a drying section where both sides of the plate are dried by infrared lamps, resulting in a minimum of oxidation. The method assures plates of uniform quality.

Harry A. Coughlin, U. S. pat. 2,555,874 (June 5, 1951), has a machine that moves a plate through a system which inks, dries, and develops the plate.

Paul J. Hartsuch, in *Printing Equipment Engineer* 81 No. 12: 60–62, Sept., 1951, reports on a high wet-strength paper wrapper for dampener rollers. The paper takes the place of the molleton cover and can be replaced readily when it becomes dirty. Arthur J. Weichsel, Inc. (New York, N. Y.) have a nonwoven fabric 0.006 in. thick of long fibered cotton, calendered to a smooth lintless surface. The material is called "Topkote," and comes in rolls 3 to 4 in. wide which can be rolled on the dampener rolls as a spiral which is held in place on the ends by patented cast metal holders.

There are a number of ink solvents and press cleaners on the market. Kelite Products, Inc. (Los Angeles, Calif.) have Kelite No. 28, a noninflammable, nontoxic material.—Armour & Co. have "Energetic," a synthetic detergent which, when used 8 oz. to 30 gal. of water, will remove ink stains in 20 min. A. E. Handschy Co. (Chicago, Ill.) have "Handco Speedie Press Kleen," a one-wash solution which is claimed to permit immediate changeover from dark to light-colored inks. The solution contains a rubber conditioner. Anchor Chemical Corp. (Brooklyn, N. Y.) has "Renolene," a nontoxic, nonexplosive, quick drying solvent with a flash point of over 100°F. which contains no carbon tetrachloride or coal tar solvents. The Knox Soap Co. (Chicago, Ill.) has a three-solvent system of (1) knockdown; (2) drag-out; and (3) isopropyl alcohol (91 or 99%). This material permits immediate changeover from dark to light inks. The Harry H. Rogers Co. (Chicago, Ill.) has a "Rogersol, 1-2-3," which makes the same claims but also acts as an excellent blanket wash and helps keep the life and tack in rubber and rejuvenates old rubber.

BAL, which has been used in medicine as an antidote for heavy metal poisoning, has been found when applied as 3% BAL in ointment in cases of chromium poisoning to be exceedingly effective. When injected, BAL (British Anti-Lewisite) was found to be of no value.

PLATEMAKING

Carles H. Voelker, Research and Development Dept. of Hubney Brothers, Inc. (Roselle, N. J.), is soft soldering aluminum and magnesium with a 50-50 lead-tin solder and no flux. No special abrading preparation is made.

The Enthone, Inc. (New Haven, Conn.) is stripping tin and lead from bases of brass, copper, gold, monel, nickel, silver, and stainless steel without attacking the base metal. The stripper is an alkaline material, used 1 lb. to a gallon of water at 160 to 180°F. The stripping action is in the order of 0.005 to 0.010 in. per hr.

F. P. Spruance, Jr., U. S. pat. 2,568,936 (Sept. 25, 1951) has a chromate method for treating aluminum to increase resistance to corrosion and abrasion. The metal is subjected to an acid aqueous solution of ingredients of which fluoride ions, dichromate ions, and ions from the class of acids consisting of phosphoric and arsenic acids. The concentration of chromic is in the range of 0.5 to 40 grams per liter.

W. F. Alexander (Cleveland Press) and R. W. Hendrich (Wire Coating & Manufacturing Co.) have a new plate for newspapers, a zinc-coated magnesium plate which can be etched for relief printing for runs under 100,000 impressions. Phototypesetting can be used in making the plate. It eliminates hot metal typesetting, mat making, and stereotyping. Halftone screens up to 100 lines can be used.

Leopold Pessel, U. S. pat. 2,560,979 (July 17, 1951), has a chemical method for the deposition of metals. Metallic coatings are deposited from solutions containing 2,4-pentanedione (I) which speeds deposition and makes deposits hard and bright. Water should be present. Steel is immersed in a solution comprising 10 to 30% (I) and 7% copper sulphate. A hard bright copper film is formed in seconds. Silver, lead, copper, nickel, bismuth, cadmium, selenium, and tellurium may be deposited by this method. For high concentrations of (I), a cosolvent such as diacetone alcohol may be used.

Stephen I. Griglak, U. S. pat. 2,522,869 (Sept. 19, 1950), has invented a removable core which fits in the stereotype casting box. These cores leave recesses in the stereotype plates, making them lighter by using less metal and reduce the trimming time.

Griglak, U. S. pat. 2,542,511 (Feb. 27, 1951), also has designed a device which produces a signal in the stereotype box when the metal reaches the proper height. This eliminates the need to control the height of the cast visually and so the stereotyper is not exposed to the unpleasant heat and fumes of the metal. The device also reduces the amount of dead metal poured into the box by indicating the level at the top of the live cast.

Vandercook & Sons, Inc. (Chicago, Ill.) have developed a new type of casting box for base metal which consists of a series of pyramid cores extending vertically through the cast. The top of each pyramid ends in a square-shaped opening on the surface of the cast which provides an outlet for gases which develop during mounting, gives a tooth for stronger adhesion, and provides openings through which the solvent softens the adhesive when the plate is to be removed. The new cast base weighs about one half as much as a solid base and is called "Lite-Base."

Mallinckrodt Chemical Works have a new cold top enamel called "Tuftop," a two-solution enamel which produces a tough, adherent coating immediately after sensitizing without aging. The top will hold halftone dots and lines even under rigorous etching.

ANILINE PRINTING

Reichhold Chemicals, Inc. (New York, N. Y.) have a maleic-resin type resin with excellent solubility in alcohol and a rapid solvent release and a high melting point. It is recommended as a shellac substitute in aniline printing.

The Flexographic Printing Subcommittee of the Printed Packaging Materials Committee of the Packaging Institute felt the term "aniline" to be obsolete, inappropriate, and detrimental to the trade. They chose flexograph in preference to aniline, permatone, and rotopake.

SILK SCREEN

The Eastman Kodak Co. has developed the Kodak Ectagraph process. It is film coated with a silver halide emulsion which can be used as a stencil in silk screen work. The substrata used to adhere the emulsion to the film base are especially compounded so that they may be easily dissolved to permit the removal of the film base from the emulsion. The emulsion is capable of reproducing the most delicate tonal gradations with high fidelity.

British pat. 653,482 has been assigned for metal silk screen inks. The pigment is ground in urea-formaldehyde or melamine resin and plasticized with an alkyd resin to give thermosetting products of suitable consistency to apply to a metal plate covered with a background of ink or paint. The metal is then baked and the process repeated for other colors.

Glidden Co. (Cleveland, Ohio) has a new high-gloss, force-dry, overprint varnish for screen printing. It can be force-dried in 2 min. under infrared lamps. It permits the work to be dried on a conveyor or table without the need of overnight racking.

COLOR

W. Harvey Glover of Sweeney Lithograph Co. (Belleville, N. J.) has developed a color matching aid, "Glover Tru-Hue Lamp," which gives June noon-day sunlight. It has a rotating color correction disk which filters the light from electric bulbs in the lamp.

The Intersociety Color Council has completed a new color aptitude test. It consists of an easel on which are mounted 48 color chips in four rows of 12 each. The rows are red, yellow, green, and blue, 12 chips to each row, varying in purity by about two steps in chroma over the entire series or $^1/_6$ step between any two chips in a series. The chips are mounted at random so that each match must be an individual decision. An automatic chip dispenser contains a duplicate set of chips which allows the candidate to have only one chip at a time, and insures proper maintenance of sequence so that each candidate makes the matches in exactly the same order. Under each chip is an open square through which the candidate marks the number of the appropriate chip from the dispenser on the score sheet inserted underneath.

Photocolour Laboratories (Walham Green, England) have a new range of fluorescent materials. "Fluorink" which is whiter than white paper or paint can be applied in such a manner to give a secondary white which will appear gray.

Gasses and Zukriegel (*Melliand Textilber* 33, No. 1: 44-45 (Jan., 1952)) have made a "Heliotest," a heliostat with a lens system attached to it. The lenses concentrate the solar rays so that they react with 25 times their normal intensity.

McDowell and Clark (Mellon Institute) have worked up a series of zein pigment chips, composed of a zein to pigment ratio of 1:1; 100 parts of blend is mixed with 8 to 15 parts by weight of a 50% aqueous 2-methyl 2,4 pentane-diol. The charge is milled about 10 min. on a two-roll rubber mill with one roll maintained at 160 to 195°F., the other at room temperature. Some organic pigments do not disperse readily but can be improved by the use of sodium sulphonate or sulphate-type surface actants. The chips are suitable for use in aniline and rotogravure type, water-base inks as well as in vapor-set and heat-set inks.

The Philadelphia and Reading Coal & Iron Co. have established a mineral research grant at Pennsylvania State College for the study of the manufacture by competitive processes of carbon and activated carbon from anthracite coal.

O. E. Miller (*J. Optical Society of America* 42, No. 9: 661–662 (Sept., 1952)) reports on an integrating light meter for measuring the light used in fading tests designed to use only commercially available components. The instrument has a d.c. measuring circuit which is linked mechanically to the a.c. integrating circuit by means of a self-balancing potentiometer servo system. The time integral of the intensity is accumulated on a commercial kilowatt-hour meter. The linearity and accuracy are better than 1% of the full registration rate.

PHOTOGRAPHIC

The American Optical Co. (New York, N. Y.) is producing the Goerz-Huebner Artar reversing lens which contains a built-in reversing prism. The image passing through the lens comes out exactly reversed, "sharp and

without distortion," and color separated images are in exact register. The lens mechanism can be rotated by hand or by motor control. A diaphragm control and holder for color separation filters are part of the lens equipment. This lens supersedes right angle cameras, stripping film, and delayed action operations.

Willis N. Urie (Santa Monica, Calif.) has a device which automatically varies the lens aperture throughout the exposure time. When the highlight is fully formed, the stop shrinks to a smaller aperture, which burns in the middle tones. When this exposure is completed, the smallest automatically set stop is in position for the final exposure.

E. I. du Pont de Nemours have produced "18-F" Universal Fixer, a hypo solution treated with an aromatic derivative of oil of lavender to mask the strong acetic acid and sulphite odors.

The chemistry of ion exchange processes is being used for the decontamination of photographic wash water and rejuvenation of exhausted hypo solutions (*Photographic Eng.* 2, No. 3: 102–109 (1951)).

Du Pont has developed a polyester related to "Dacron," a polyester fiber from ethylene glycol and terephthalic acid condensation. Preliminary tests show that a film from this material is several times tougher than present types of film base. It has a much better dimensional stability and as a safety base it is less flammable and lacks brittleness at low temperatures.

M. P. Blaber reports in *Chemistry & Industry* 1951: 759, on a method of impregnating gelatin with a phenol-formaldehyde resin. Dry gelatin relief images on photographic materials are soaked 10 to 30 min. in a solution made by adding 40 grams of sodium hydroxide in 620 cc. of water, to a mix of 1000 grams of phenol and 1875 cc. of 40% formalin. Heat 3 hr. at 65°C., neutralize with lactic acid and remove water by distillation. The swollen gel is then heated 1 to 2 hr. at 80°C. to give a deep, hard relief image.

Photographic Engineering 2, No. 2: 77 (1951) tells about a new photochemical lamp which has a more uniform, higher UV output. These lamps are found especially adapted for use with the Diazo white-print machine. The results are due to the type of glass and electrodes which have been used. The lamps utilize a medium pressure mercury arc.

The John P. Filbert Co., Inc. (*GAM*, May, 1952: 194) in the "Spectro-Lite" succeeded in blending the primary colors of the spectrum, thereby producing a white light of 6000 Kelvins on the spectra meter. This is the color temperature of natural daylight.

Philip E. Tobias, research engineer of Edward Stern & Co., Inc. (Philadelphia, Pa.), as a result of a study has found that pressroom illumination should not be less than 6500 Kelvins or the equivalent of a slightly overcast north sky. He has found that using fluorescent tubes, two daylight, one blue, and one deluxe-cool mounted in a reflector box, two boxes to a unit, gives approximately 7000 Kelvins.

The Litho Research & Engineering Co. (*GAM*, Nov., 1952: 200) is producing a copyrighted sheet having guide lines which speed the positioning of masking and negatives. Plates can be made on which the image is so correctly positioned that the pressman can set the feeder and delivery without first seeing the plate and the first sheet pulled will be found to be within $^1/_8$ in. of the correct position.

Reed, DeBroske, and Cole, of the National Institute of Health, have developed an apparatus which permits the masking of 35-mm. colored transparencies during the manufacture of color separation negatives. The process of masking this size transparency has up to this time been quite a chore for the cameraman.

The Aluphot plate and process is a Swiss invention which provides a method for making photographic reproductions on an aluminum base. The method consists of developing a photographic image in the anodized layer of a photosensitized, anodized aluminum sheet. After exposure and sensitization in a standard darkroom printer, the image is developed by a manner comparable to that used in ordinary silver halide gelatine emulsion type pictures. The image is substantially grainless with a high degree of resolution and continuous tone and is not affected by nuclear radiations.

Ralph B. Atkinson and Steven G. Ellis (*J. Franklin Inst.* 252, No. 5: 373–381 (Nov., 1951)) have a process called "Ferrography," which can record graphic information by the use of magnetic retentive properties of ferrous materials and the magnetic attractive properties of other ferrous material to record and assume the shape and opacity of the image.

Charles F. H. Allen and James A. Van Allan have received U. S. pat. 2,566,302 (Sept. 4, 1951) for light-sensitive resins. These are copolymers useful in photochemical resists. Results are obtained by a reaction of polystyrene with a light-sensitive acid chloride in the presence of aluminum chloride, or reaction of acid chloride with monomeric aryl compounds followed by polymerization. The patent states that for ready solubility and good sensitivity to light, 5 to 18 moles styrene to 1 mole of cinnamostyrene in the product is satisfactory. Several solvents for removing the unexposed copolymer are listed.

Trans-Gel Products, Inc. (Queens Village, N. Y.) has "Perma-stat," a dichromate stabilized emulsion on a base material which, when exposed under a negative with a carbon arc or sun lamp, gives an image which, when dipped in a dye solution, followed by a cold water rinse, gives a colored image. According to the report, any number of colors may be registered on the plate.

Frank Preucil (*National Lithographer* 58 No. 9: 34–35, 108, 110 (Sept., 1951)) reviews the most recent progress in the electronic scanner.

Francis P. Callahan, Jr. (*J. Optical Society of America* 42, No. 2: 104–105 (Feb., 1952)) discusses the effect of halftone prints on their appearance due to light scattering.

BINDERY

The *USI Chemical News*, Oct., 1952, reports a lacquer which can be applied by brush, dip, or spray which dries in 3 to 5 min. at room temperature to give a smooth coating similar to a sandblast finish which is less inclined to hold dirt than a real sandblast finish.

Boxboard Containers 69, No. 707: 28, Nov., 1951, is an article which tells how a vinylite plastic rigid sheet form can be used in folding paperbox plants to check register between cutting dies and printing plates. The transparent plastic has exceptional dimensional stability and, because of its resistance to moisture, grease, ink, and most chemicals, can be re-used several times.

Coating Products (New York, N. Y.) have a series of metallic acetates and polystyrenes which come in every standard color; can be formed, folded, die-cut, stitched or sewn, laminated or glued, embossed and printed with silk screen, lithography, or gravure.

USI Chemical News, Jan., 1952, tells about a synthetic water-soluble animal glue in the form of small amber pellets. The glue makes paper impervious to all organic solvents, oils, greases, waxes, and other nonwatery but penetrative products. Applied in a hot solution in a continuous film, it makes containers impervious to these solvents. Hot tars and asphalts do not adhere to the coating.

Arma Co. (Canton, Ohio) has a new paste-up method which is made on paper called "Thermium Paper." When heated, this paper adheres to other papers. Proof can be pulled or typed on this paper and it can be spotted on the copy board. If proofs are on other paper, thermium can be used as an adhesive. Heating tools are thermostatically controlled to prevent overheating.

Minnesota Mining & Manufacturing Co. has a dry film thermosetting adhesive, "Scotch-Weld Adhesive No. 583" which can be used to mount plates on wood base. The bond is stronger than the wood base. The plates can be removed after use by reheating 30 sec. at 350°F. under low pressure.

Pitney Bowes, Inc. (Stamford, Conn.) have an office folding machine which folds with precision 5000 sheets per hr. It can perform two parallel folds in one operation and can make any one of eight basic types of folds handling a wide variety of paper sizes and weights.

Berlin & Jones, Inc. (New York, N. Y.) have a counting and banding machine which takes 30,000 an hour, loose envelopes or cards, stacks, squares, counts, and bands them in groups of 12 or 25 ready for shipment.

The Potdevin Machine Co. has a new 50-in. wide combination conveyor, gluing machine, and laminator. It is designed for sheet and rolls with a hot unit for hot glues.

Alltex Rubber & Chemical Co. (New York, N. Y.) has a new adhesive resin which is recommended for a packaging seam adhesive for fabrication of specialty bags from plastic to coated kraft stocks and for greaseproofing paper.

Paasche Airbrush Co. (Chicago, Ill.) has a "Cuelf" electrically heated airbrush which heats both the air and the material and is ideal for high-speed efficient application of paraffin and waxes. It heats from 80 to 300°F. and has thermostatic control.

Polymer Industries (Astoria, N. Y.) has an adhesive for silicone-treated surfaces. "Glas-weld" will adhere silicone coated paper, wood, ceramics, and metals.

TESTING INSTRUMENTS

RCA Laboratories (Princeton, N. J.) have a new vibrating-plate viscometer which indicates directly on a meter, readings within a range of 0.1 to 1,000,000 with an accuracy within ±5%. Viscous damping by the liquid on a flat plate oscillating in the liquid is measured by an electrochemical traducer. As small an amount as 0.5 ml. can be handled as long as a long, thin, flat metal plate can be immersed in the liquid. Measurements can be made in a few seconds.

Rich-Roth Laboratories (East Hartford, Conn.) have an ultrasonic viscometer "Ultra-Viscoson" for continuous automatic viscosity measurements, using ultrasonics.

Harry H. Hull, Jr. (*J. Colloid Science* 7, No. 3: 316–322 (June, 1952)) reports a band viscometer composed of hardened stainless steel shear blocks thermally insulated from the mounting structure. A constant temperature water bath is used to control the shear block temperature within ±0.05°C., a timing unit and cellulose tape. The sample is subjected to a uniform shearing force throughout and the heat formed is dissipated efficiently. The instrument operates at shear rates up to 10,000 reciprocal sec. and is easy to operate.

Union Carbide & Carbon Co. has a pressurized viscometer called the Severs extrusion rheometer which is being handled by the Castor Laboratory Equipment Co. (Lebanon, Pittsburgh, Pa.). This instrument is especially suited for dispersions, inks, organosols, plastisols. Viscosity is in terms of pressure, quantity, time, and orifice size. Various orifice sizes are available.

The National Instrument Co. (Baltimore, Md.) is producing a 50-power pocket microscope with a liner scale measuring 0.002 in.

L. Pihl, reporting for the Graphic Arts Research Laboratory of Sweden, tells of their drying time recorder which is a drum type, recording by the offset principle using a single ball pen stylus under 50 to 100 grams weight.

The Institute for the Graphic & Allied Industries (Amsterdam, Holland) has developed a print tester which consists of an inking system and a printing system. The inking system is composed of two steel rolls, one composition roll, and a printing form (a brass disk 10 mm. thick). The printing form is inked in the inking system for a definite time, and then placed in the printing system. The paper sample is mounted on a segment of 150°. Printing is produced by dropping a pendulum which actuates the paper segment against the ink roll. By means of this instrument, the paper can be tested for pick, density of print, printability, and rate of ink absorption. Smoothness can be determined by using a light pressure and a light inking.

This same institute has a drum-type drying time recorder similar to that reported by the Swedish laboratory, but uses an arm holding a steel ball, 3.2 mm. diameter, for recording. This arm can be adjusted from 50 to 135 grams pressure.

Wheeler and Reed have the LTF pick tester. An unbalanced fly wheel acts as a pendulum, causing a spring-loaded inked hammer to strike the paper sample. The instrument uses a series of eight tack-tested inks. The pressure period of contact and rate of separation are adjusted to give the same results as an offset press at normal printing speed.

Walker & Zettlemoyer (National Printing Ink Research Institute) have developed the NPIRI planetary rubometer. The instrument is placed directly on a portion of printed matter to be tested. A 1.5-in. square of the material to be rubbed is placed on the rubbing foot. The machine can be set to give the desired number of rubs under a definite pressure and the sample or pattern formed examined.

The Sutherland Paper Co. (Kalamazoo, Mich.) also has developed a rub tester.

Erwin W. Muller of Pennsylvania State College has

a field emission microscope which will give magnifications of from 100,000 to 1,000,000 times. The emission is bright enough to photograph or to project on a screen in an auditorium. An extremely fine needle sealed into one end of an evacuated tube is pointed at a fluorescent screen in the other end. The release of electrons from a cold metal surface under electrical pressure of 5000 v. is applied to the needle. This creates a field strength of about 125 million v. per in. on its tip. Electrons stream away from the tiny hemispherical tip in a direction almost perpendicular to the surface at every point. Thus, the electrons map out on the fluorescent screen an enlarged picture of that surface.

At atomic thickness gage has been developed by George B. Foster, Nucleonics Corp. (Columbus, Ohio). The gage is installed along the production line and charts irregularities in the thickness of the product. The gage uses strontium-90, a beta-ray emitting waste of uranium fission.

LETTER TO THE EDITOR

Tropical Woods

To the Editor, *Tappi:*

In checking through a reprint of "Tropical Woods as a Source of Pulp" (*Tappi* 35, No. 4: 129–190 (1952)), I noticed an error and an omission in our paper entitled "Species Sampling on a Reproducible Basis." The error occurs in the second formula on page 132, viz., $\bar{x}$ is given as $\bar{x}_i$; the omission occurs in the fifth line of the first paragraph on page 133, viz., just after "for any species." A whole page of typescript has been omitted.

I trust that this rather belated comment will be of some use to you. Following is the text of the missing page.

Project a horizontal line from the point of intersection of the appropriate "coefficient of variation" curve with the desired "95% fiducial half-range" ordinate, to the abscissa axis. For example, if the calculated coefficient of variation is 15%, then for the chosen fiducial half-range of 5%, the approximate number of trees required is 37.

4. *Collect additional randomly selected samples as described previously.* The number should be sufficient to bring the total number of samples up to 75 or 80% of the approximate number estimated from Fig. 3, i.e., in the example under consideration, collect 18 (28 − 10) additional samples.

5. *Determine pulp yield on each of the additional samples.* Then, after calculating the new coefficient of variation, make a second approximation to the total number of trees required. Suppose the new coefficient of variation to be 13%. Then the number of trees required is about 30.

6. *Collect the two additional samples (30 and 28).* Determine the pulp yields and recheck the coefficient of variation.

7. *Calculate the estimated species mean.* The pulp yield for a composite sample prepared as described earlier, should, in 95 cases out of every 100, be within the prescribed fiducial half-range of the estimated species mean.

With the method of sampling described, the estimated species mean and the composite sample represent the timber on the volumetric basis. However, analytical determinations are normally expressed on a weight basis. Hence, for highly accurate sampling, allowance should be made for variations in the density of the wood Variation of basic density with height in a tree is generally small compared with between-tree variation (Greenhill and Dadswell, 1940).

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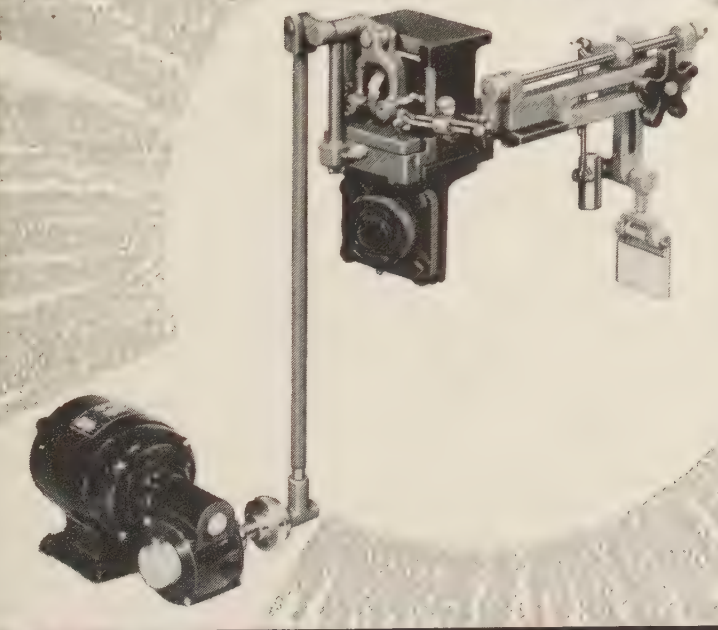

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The Chemical Composition of the Internodes and Nodes of Soft Wheat Straw

SIDNEY D. WELLS and BERTIE L. BROWNING

In some recent work on the pulping of straw from soft wheat, typical of that used by the strawboard mills in the soft wheat areas of the Central States, the question arose as to the chemical composition of the fibrous residues derived from the nodes as compared with the internodes as a basis for evaluating the merits of removing the softened nodes before preparation of pulp obtained for papermaking. The literature on the use of straw for papermaking is very extensive, 932 references occurring in West's Bibliographic Series, Papermaking Materials, Part I, Cereal Straws, October, 1949, but in all this material there were no data which delt specifically with the chemical composition of the nodes as differentiated from the internodes.

A representative sample was obtained from the straw stacks of a midwestern mill and the nodes were separated from the internodes by a very tedious process of taking stems of straw from the sample and separating the nodes from the internodes with scissors, one stem at a time. The rachis were discarded as beyond the scope of the study, but the leaf sheaf and fragments of the leaves adhering to the stem were included as belonging to the internode sample. The weights of the two fractions are shown in Table I.

Table I

	Internodes, g.	*Nodes, g.*	*Total, g.*	*Internodes, %*	*Nodes, %*
Sample 1	99.4	9.0	108.4	91.7	8.3
Sample 2	124.9	12.2	137.1	91.1	8.9
Average	...	...	...	91.4	8.6

The results of the chemical analysis of the stems less the nodes and of the nodes are shown in Table II.

Table II. Analysis of Straw
All results in per cent

	Stems (less nodes)	*Nodes*
Ash[a]	5.6	9.0
Silica in ash[b]	55.1	26.3
Pentosans[a]	23.7	24.8
Alpha-cellulose[a, c]	40.2	32.6
Lignin[a, d]	19.5	17.0
Hot water solubility[a]	13.5	19.6
Sodium hydroxide solubility[a, e]	32.3	33.3

[a] On the basis of original oven-dry sample.
[b] On the basis of ash.
[c] Corrected for pentosans and ash.
[d] Corrected for ash in lignin.
[e] Determined on the residue from the hot water solubility test.

All the analyses were carried out in duplicate, and the average values are reported.

Composite samples of each of the two fractionations were macerated by using caustic soda of a concentration of 100 grams per liter and a sufficient volume to cover the material. The temperature of treatment was between 90 and 100°C.

Photomicrographs of the macerated fractions are shown in Figs. 1 and 2.

On the basis of the amount of material in each fraction as shown in Table I and the analysis shown in Table II, the amount of each component in the product made from straw without removal of the nodes would be expected to be as shown in Table III.

In the period between 1926 and 1930, a Millspaugh wet-end machine was installed on the no. 5 machine of the North Star Strawboard Mill at Quincy, Ill. With the stock preparation method available at that time the presence of nodes in the furnish detracted from the appearance of the sheet so that Bird screens were installed to clear up the sheet even though

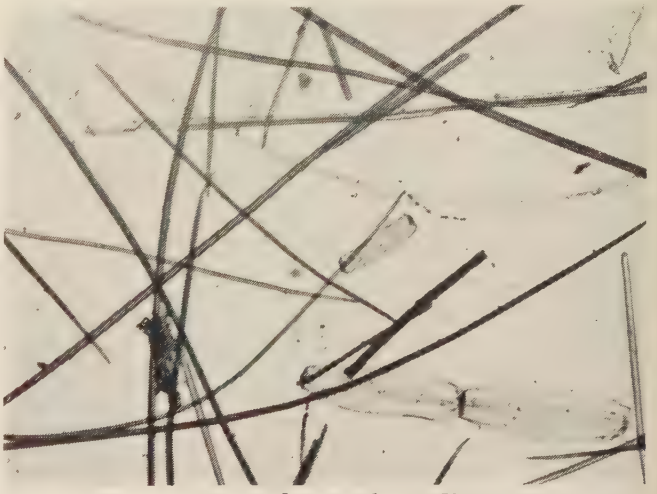

Fig. 1. Internodes × 50

they added nothing to the value of the sheet for corrugating purposes. The screenings were discarded. During this period, samples of the rejects were shipped in drums to the Forest Products Laboratory at Madison, Wis., and run through the 2½ by 5-ft. rod mill available there. The stock obtained was run over the fourdrinier paper machine into a corrugating paper which was given the usual physical tests and found to be entirely satisfactory, except for the shortness of the fiber. It was obvious that a pulp containing less than 10% of such stock in the total furnish could be used without affecting the over-all properties desired and the stream pollution caused by the disposal of the screenings and the waste of paper stock caused thereby could be avoided without loss to the mill in which they occurred.

Table III

Ash	5.9%
Silica	2.9%
Pentosans	23.8%
Alpha-cellulose	39.5%
Lignin	19.3%
Hot water solubility	14.0%
Sodium hydroxide solubility	31.4%

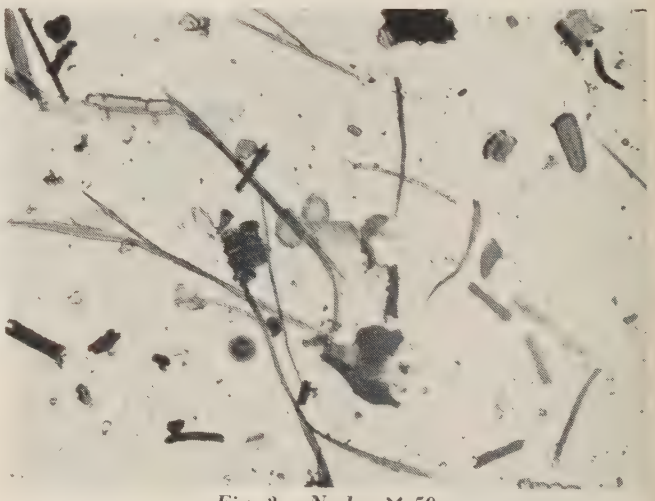

Fig. 2. Nodes × 50

Sidney D. Wells and Bertie L. Browning, Research Associates, The Institute of Paper Chemistry, Appleton, Wis

The authors wish to thank Harold L. Jones for the analyses reported in this paper. They are also grateful to Robert C. McKee and Irving H. Isenberg for suggestions throughout the course of the work.

Some Economic Aspects of Burning Sulphite Waste Liquor

W. J. DARMSTADT and F. H. RICHTER

In recent years the sulphite pulp industry has intensified its efforts to find a satisfactory solution to the waste liquor disposal problem. This has been brought about by increasing fuel and chemical costs, increasing pressure toward abatement of stream pollution, and the need for more efficient utilization of natural resources. With the objective of disposing of the liquor by some useful means, three main avenues of approach have been thoroughly investigated. One approach has been to make use of the liquor constituents by conversion into various chemical products such as alcohol, yeast, and vanillin. Another has been to take advantage of the physical properties of the liquor for such uses as road binder and adhesives. The third approach has been to burn the liquor for its heat value, or for its heat and chemical values.

The first two methods of disposal depend for their success on markets external to the pulp and paper industry, and at present the supply of liquor for conversion is far in excess of the market demand for the products so far developed. It appears that general application of these two methods of disposal must await further long-range developments.

With the development of suitable evaporators, the concentrating of sulphite liquor is now practical, and disposal may be accomplished by burning with recovery of the heat value of the liquor. A process for the recovery of both chemicals and heat, using magnesium oxide as the base, has been developed and applied on a commercial scale. These developments have intensified the industry's interest in disposal by burning and many mills are examining the possibilities of application to their particular mill.

Under proper conditions, burning the liquor and recovering the heat will result in a considerable reduction in the amount of fuel to be purchased by the mill, and these fuel savings are available to offset the capital and operating costs of the disposal system. The fuel savings depend on the amount of fuel saved and on the local price of commercial fuel. Chemical recovery in addition to heat recovery will reduce the mill chemical costs and will thus increase the possible savings from burning.

Since considerable investment in equipment will be required to collect, evaporate, and burn the liquor, the savings in fuel, or in fuel and chemical, must be evaluated against the investment and increased operating costs to determine the over-all economics of disposal by burning. Some mills contemplate only partial disposal of the available liquor solids while others are thinking of complete disposal. The economics of disposal by burning will vary with the percentage of the available liquor solids that is collected and burned, primarily because of the effect of the liquor collection method on investment and operating costs. For limited recovery and disposal of solids, displacement washing in existing blow pits may be utilized whereas for complete disposal an improved means of washing is indicated.

We would like to discuss some of the economic factors bearing on heat and chemical recovery, and to describe some of the problems incident to the actual burning operation. Since the total investment in recovery equipment required for any particular mill will depend largely on conditions in that mill, it would be difficult and misleading to approximate such figures. The savings in heat and chemical for various conditions of operation may be fairly closely approximated, however, so that some idea may be had as to how much investment might be justified.

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HEAT RECOVERY

Since any net monetary return from burning for heat recovery is in the form of reduced fuel expenditures, the questions naturally arise, "how much heat value is there in the liquor, and how much can be usefully recovered and used to reduce the fuel bill? Will the fuel savings be sufficient to offset the capital and operating costs, or will there be a difference that must be charged against disposal?"

The fuel value of sulphite liquor is derived from the wood used for cooking. The amount of combustible made available from the wood may be approximated as the difference between the weight of the dry wood and the pulp yield in per cent. On this basis, and assuming a yield of 47%, approximately 2256 lb. of combustible per ton of pulp would be available. Analyses have indicated that the heating value of the combustible on a dry basis is approximately 9000 B.t.u. per lb.; thus there are approximately 20,300,000 B.t.u. per ton of pulp available in the liquor. This is roughly equivalent to 1450 lb. of 14,000 B.t.u. coal.

For a 100-ton mill this would be equivalent to a savings of $725 per day, based on coal at $10 per ton. These savings will not be realized, however, since some of the steam generated from burning must be used to condition the liquor for burning. Before the liquor is suitable for firing, the solids concentration must be raised by the evaporation of water. Also some steam may be used for heating and atomizing the liquor for burning. The difference between the gross steam generated by burning and the steam used for conditioning the liquor is available for use in the mill and represents the fuel saved.

PROCESS REQUIREMENTS

To recover heat from sulphite liquor by burning, three major operations are necessary: (1) separation of liquor from pulp, (2) evaporation of liquor to a burnable concentration, and (3) burning of liquor and recovery of heat from combustion gases.

In the majority of calcium-base sulphite mills, the separation of the liquor from the pulp is performed in the blow pits. A certain amount of liquor, containing about 40 to 60% of the solids, resulting from the cook, can be separated from the pulp by drainage and displacement washing and will be at maximum solids concentration of about 10 to 12%. The remainder of the liquor solids is usually washed from the pulp by addition of water to the blow pit. The effluent, which contains the liquor solids to be disposed of, becomes more dilute as the degree of washing increases.

It is interesting to note that in a pound of 10% solids liquor, there are insufficient B.t.u. to evaporate the 90% water. Therefore, for reasons of heat economy, evaporation of the liquor to a burnable concentration is usually performed in multiple effect evaporators where 1 lb. of steam fed to the evaporators will evaporate several pounds of water, the ratio depending on the number of evaporator effects. Any water in the liquor leaving the washing operation must be evaporated either in the multiple effect evaporators or in the furnace. Since evaporation in the furnace is by application of direct heat and at the heat economy of 1:1, the amount of evaporation done in the multiple effect evaporators should be as great as practical. Due primarily to the rapid increase in viscosity of the liquor with increase in solids concentration, the practical upper limit of evaporation of sulphite liquor in multiple effect evaporators is reached somewhere between 50 to 60% solids concentrations. With suitable burning equipment concentrations in this range are adequate for good combustion.

Following evaporation, the liquor can be burned in a suitable furnace, and high pressure steam generated in a suitably designed boiler. The details of application of furnace and boiler will be discussed later under the subject of burning and steam generation.

Fuel Savings

Since calcium is the base in general use, first consideration might naturally be given to burning calcium-base liquor. The savings in fuel, and the factors determining the economics are, for practical purposes, the same for any of the common bases and what is said for calcium base can be applied to burning the other bases.

The gross steam generated per ton of pulp produced will depend primarily on the percentage of available solids to be burned and on the over-all boiler efficiency. The net steam, or fuel saved, will depend primarily on how much of this gross steam must be used to concentrate the liquor to a burnable concentration. The gross and net steam may be fairly closely approximated by making certain assumptions, and to illustrate what might be expected in the way of fuel savings under various conditions, Fig. 1 has been prepared.

This figure shows how the gross steam generated and net steam resulting vary with the percentage of total available solids recovered and burned, and with the solids concentration entering the multiple effect evaporators. Plotted against per cent recovery of solids per ton of pulp are gross steam generated; net steam after evaporation, liquor heating and atomization; and, dollar value of the net steam. Per cent recovery of solids is the percentage of the total available solids that is taken for burning. The per cent solids curves refer to the concentration of the recovered liquor leaving the liquor separation operation and entering the multiple effect evaporators. From the curve the fuel savings may be approximated for the range of 30 to 100% disposal of solids, and for liquor solids concentrations of 6 to 20% entering the multiple effect evaporators. In drawing the curves, the following assumptions, which we believe are reasonable, have been made:

1. Two thousand five hundred and eighty pounds of total solids per ton of pulp (including chemicals) at 100% collection.
2. Heating value of solids 7900 B.t.u. per lb.
3. Fifty-five per cent solids liquor concentration leaving multiple effect evaporators.
4. Quintuple effect evaporators with a steam economy of 3.8:1.
5. Sixty-five per cent over-all boiler efficiency.
6. Steam figures expressed on "from and at 212°F." basis.
7. Steam valued at 50¢ per 1000 lb.

It will be seen from the curve that the possible fuel savings are greatest at maximum solids recovery and with maximum concentration of liquor to the multiple effect evaporators. With the commonly used blow pit method of washing the concentration of the liquor to the evaporators may drop sharply as the amount of solids recovered is increased beyond that afforded by drainage and displacement. This condition has a pronounced effect on the fuel savings and on the over-all economics. Two cases may illustrate this point.

Assume that a sulphite mill plans to dispose of 35% of its liquor solids which may be reclaimed by drainage and displacement washing in the blow pit at, let us say, 10% solids concentration. The curve indicates that 4600 lb. of steam per ton of pulp will be generated, and boiler capacity of this amount must be provided. The net steam remaining after evaporation of the liquor from 10% solids to 55% solids is shown to be 2500 lb. per ton of pulp. The fuel savings thus amount to $1.25 per ton of pulp which, less the operating costs, may be applied to retiring the investment in evaporating and burning equipment.

Assume now that the mill must dispose of 70% of its solids, or twice as much as in the first case. With the amount of blow pit washing necessary to obtain 70% of the solids, the concentration of the effluent drops sharply and might fall to, say, 6% solids. With 6% solids entering the evaporators, Fig. 1 shows that the steam generated will be 9200 lb. per ton, but the net steam has fallen to 1900 lb. per ton resulting in a fuel saving of 95¢ per ton of pulp. This saving is even less than the $1.25 saving at 35% recovery of solids even though

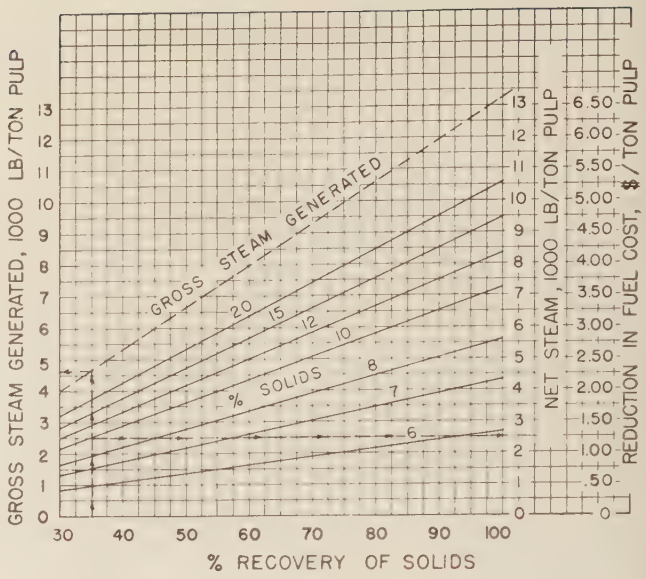

Fig. 1

twice as much steam has been generated. Not only have the savings been reduced, but the investment has been increased since twice the boiler capacity, and more than three and a half times the evaporator capacity will be required. It is obvious that the washing and dilution in the blow pit could be carried to the point where the steam required for evaporation would equal the gross steam generated and no net steam would result. Disposal would have been accomplished but no savings would be available to apply against the capital and operating costs.

Referring again to the 70% recovery illustration, if the solids concentration leaving the digester were increased, and an improved washing system were installed so that the liquor concentration entering the evaporator could be increased to 10% the fuel savings would be $2.70 per ton. At the same time, the evaporator capacity required would be considerably less than that required for 6% liquor concentration.

It is apparent from the foregoing that the concentration of the recovered liquor fed to the evaporators is a major factor in determining the amount of fuel saved. This concentration is dependent on the liquor concentration leaving the digesters and on the amount of water added during the washing operation, and is subject to some control. To raise the concentration leaving the digesters, consideration might be given to the use of indirect steam in those mills using direct steam for cooking. Consideration might also be given to decreasing the acid-to-wood ratio, and to recycling a portion of the spent liquor. Installation of an efficient washing system will permit separation of the liquor solids from the pulp with low dilution. All of these methods will require some further investment or changes to present procedure and what is possible or economical to do in one mill may not be in another. Economic studies for individual mills will indicate how much should be spent to increase the fuel savings.

Before stating some generalizations on the over-all economics of burning for heat recovery, the actual burning problem should be discussed.

Burning and Steam Generation

The authors' company first burned calcium-base sulphite liquor in a boiler in 1936. Commercial pilot plant operation and burning of magnesium-base sulphite liquor in 1937 was reported by Tomlinson and Wilcoxson (*1*). Since that time numerous field trials of sulphite liquor burning have been conducted in cooperation with others. Baker and Wilcoxson (*2*) reported on the full-scale commercial operation of magnesium-base heat and chemical recovery. The pilot operation of burning calcium-base sulphite waste liquor in a converted

stoker-fired boiler was reported by Rogers and Jolley (3) in 1950. In each of the above installations the waste liquor was burned independently of auxiliary fuel. Oil auxiliary fuel was used for starting up but once the liquor firing was stabilized, auxiliary fuel was not required.

This experience has indicated that the major technical problems of burning sulphite liquor have been solved. Commercial installations for efficient burning and heat recovery may be made with confidence and with the application of sound engineering principles.

Referring again to Fig. 1, the curve labeled gross steam generated indicates approximately the necessary capacity of burning and steam generating equipment that must be provided for each degree of solids collected and burned. It is seen that this capacity depends on the amount of solids to be burned, or the per cent recovery of solids, and is independent of the solids concentration to the evaporators.

Since all mills have a boiler plant the question naturally arises as to whether the liquor can be burned in these boilers. Can they be used as they are, or will alterations be required? If they should be altered, what must be done to assure good results when firing sulphite liquor?

To answer these questions the nature of sulphite liquor as a fuel must be considered. In comparison to coal, oil, and gas, sulphite liquor is a low-grade fuel. The B.t.u. content of the solids on a dry basis is only slightly greater than half the B.t.u. value of coal, and in addition, the liquor as fired is approximately half water. Sulphur in any fuel is of some concern due to its corrosive actions and influence on boiler deposits, and sulphite liquor is high in sulphur content. The ash content is high, and while the ash fusion temperature is above the temperature encountered in burning, the presence of small amounts of sodium and potassium in the ash may cause adherence of ash to heating surfaces.

From our experience in burning magnesium and ammonia-base liquor commercially, and from participation in numerous field burning trials on calcium-base liquor, the design requirements for efficient combustion and heat recovery units have been determined. The requirements can readily be met in the design of new furnace and boiler units and might be met on some units already installed by making proper modifications.

The design requirements might be illustrated best by describing a unit designed specifically for sulphite liquor firing. This unit would be one equipped with a refractory furnace to permit burning without the use of any auxiliary fuel. Steam atomizing burners would be used, and a gas air heater would be provided to supply preheated air for good combustion and to improve the over-all efficiency by lowering the gas temperature leaving the boiler. Proper tube spacing and cleaning devices would be provided to minimize ash deposits on heating surfaces. Provision would be made in the design to assure that no parts of the heating surfaces would fall to a temperature where corrosion might be encountered. Properly sized fans would be provided, and ash hoppers and a dust collector would be incorporated in the design.

Modifications to existing units should follow as closely as possible the design requirements of a new sulphite unit. The cost of the modifications, and the degree of success attained will depend on such factors as: type, size, and condition of furnace and boiler, amount of boiler heating surface, and draft and space limitations. Some of the studies we have made for mills investigating the conversion of older units have indicated that several small units would have to be converted, and surprisingly, the cost of conversion was about equal to the cost of one new sulphite unit.

The possibility of firing liquor simultaneously with a standard fuel in the same furnace has also been considered by some. Firing of sulphite liquor in the same furnace with a solid fuel can only be done with a loss in efficiency and operating flexibility.

As the amount of liquor to be disposed of increases, the problem of adapting existing boiler units to sulphite firing becomes more complex and more costly. If the maximum amount of liquor is to be disposed of, it may be desirable to install a new furnace and boiler unit designed specifically for sulphite liquor firing.

Over-all Economics of Heat Recovery

The preceding discussion of steam generation and fuel savings has indicated generally how the savings and required investment in equipment may vary from mill to mill, and with conditions in a specific mill. Each mill contemplating disposal by burning should make its own economic study to determine if the anticipated fuel savings will be sufficient to offset the estimated capital and operating costs.

As with other types of production equipment, the unit cost of heat recovery equipment and the unit cost of operation decreases with increasing capacity or, in this case, with mill size. Since the unit fuel savings in dollars per ton of pulp are the same, regardless of mill size, it will be appreciated that there will be a break-even point expressed as a mill size where the savings will just balance the costs of the heat recovery system. For mills having a capacity above this break-even point size, the savings will be greater than the costs, and disposal will have been accomplished at a profit. For mills having a capacity below the break-even point, the savings will be less than the costs of the system, leaving a balance which is chargeable to disposal.

Although conclusions to the over-all economics of disposal by burning should not be drawn except by individual mill study some generalizations might be safely made based on the results of our studies.

For partial disposal of liquor where displacement washing in blow pits may be utilized without excessive dilution, the fuel savings in many mills will be sufficient to offset the charges for equipment and operation. No investment will be required for washing equipment, and conversion of existing boilers may be satisfactory at not too great a cost.

For maximum disposal of liquor, or for disposal closely approaching maximum, blow pit washing is uneconomical and investment in an efficient washing system will be necessary. Considerable investment must be made in converting existing boilers, or a new unit may be installed. With fuel prices resulting in a steam cost of 50¢ per 1000 lb., the anticipated fuel savings under these conditions will not completely offset the capital and operating costs, except possibly in the case of the very large mills in high fuel cost areas.

HEAT AND CHEMICAL RECOVERY

If the cooking chemicals in addition to heat could be recovered as a result of burning, the possible savings would be increased and the economics of disposal would be improved. Of all the bases commonly considered for sulphite pulping, magnesium oxide is the only one for which a satisfactory chemical recovery process has been proved. In addition to heat, the greater portion of the combined sulphur and base chemical may be recovered and reused, thereby reducing the chemical costs of the mill. Due to the high unit cost of MgO, it is essential that maximum recovery of solids be made so that only a small amount of MgO is needed as make-up.

For those mills contemplating maximum disposal of liquor, the use of MgO as a base should be considered so that chemicals and heat may be recovered. Heat recovery with MgO base requires an efficient washing system, an evaporator, and furnace and boiler unit as with other bases. Thus the investment and operating costs for heat recovery equipment will be the same as for the other bases, and the fuel savings will be the same. For chemical recovery an incremental investment in cooling and absorption towers for recombining the chemical is required, but this investment is more than paid for by the value of the chemical saved, leaving a balance as profit or as a credit against the costs of heat recovery.

By properly burning magnesium-base sulphite liquor, SO_2 and MgO are direct products of combustion, the SO_2 being in a gaseous state, and the MgO being in the form of a light, granular ash. The MgO is swept through the boiler unit by the gases and then is separated from the gases and made into a water slurry. The gases are then further cooled in a spray tower before being introduced into the absorption towers where the SO_2 in the gas is recombined with the MgO slurry to form bisulphite acid.

Published results from the Weyerhaeuser MgO installation indicate that a recovery efficiency of 88% of the MgO and 70% of the combined sulphur might be expected in a well-designed system. If chemical costs are taken to be \$65 per ton for MgO, \$35 per ton for sulphur, and \$4.50 per ton for $CaCO_3$, the savings realized from chemical recovery would be approximately \$2.80 per ton of pulp produced. The heat recovered by burning, as with the other bases, will depend on the solids concentration which in turn depends on digester and washer operation. Assuming 11% solids concentration to the evaporators, the fuel savings shown by Fig. 1 amount to \$3.50 per ton of pulp produced. In addition, for those mills using live steam for heating water, an added saving of approximately \$1.75 per ton may be realized from the heat recovered in the cooling tower. Thus the total savings from heat and chemical recovery would be \$8.05 per ton of pulp, as against \$3.50 for heat recovery alone.

The added savings made possible by chemical recovery will cause the break-even point to occur at a smaller mill size, so that more mills will be able to offset the capital and operating costs with fuel and chemical savings. In the case of the smaller mills below the break-even point, the added chemical savings will reduce the amount to be charged to disposal. Thus, chemical recovery in addition to heat recovery will improve the economics of disposal for all size mills which contemplate maximum disposal of liquor by burning.

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Inhibiting Oxidation of Waxes Used on Wrappers and Cartons

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One of the most important industrial uses for paraffin wax, microcrystalline wax, or modified wax blends is in the coating field, especially by paper and container manufacturers as a coating material for the production of moistureproof wrappers and cartons. During application of the wax or blend to the paper stock, it is customary to heat it to a temperature of the order of 160 to 200°F.

Paraffin wax, when heated to such temperatures, tends to oxidize, the degree of oxidation depending upon such variables as metal catalysis, temperature, surface of exposure, time at elevated temperature, and presence of oxygen. Oxidation of the finished coated product is accelerated by light, particularly sunlight. Some of the effects of oxidation observable in the resolidified wax are loss of hardness and tensile strength, discoloration, and offensive odor. These properties are obviously undesirable from the standpoint of use of the wax as a paper or carton coating material, particularly where the paper or carton is to be used in the packaging of such items as food products, drugs, and cosmetics.

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Deterioration of waxes and blends by oxidation can be prevented by the use of inhibitors. Some of the earlier inhibitors were unsatisfactory because they failed to meet some of the basic requirements, such as solubility, compatibility, efficiency in controlling development of objectionable odor, color or taste, effectiveness in preserving physical properties, and price. In addition, freedom from acute and chronic toxic effects is essential. As a result of these stringent requirements, very few materials are satisfactory for use as wax inhibitors. Several commercially available antioxidants which have been approved for use with edible products have a number of undesirable properties in addition to high price which limits their wide application.

An antioxidant investigated in the laboratories of Koppers Co., Inc., has demonstrated its effectiveness for inhibiting petroleum wax and wax blends against oxidation. This antioxidant, di-tertiary-butyl-para-cresol (DBPC*), did not impair the quality of the wax by imparting color, taste, and odor, as established by a series of accelerated tests. The quantity of the inhibitor varied, depending upon the susceptibility of the wax; but in general, 0.01 to 0.05% by weight showed exceptional results. The inhibiting agent can be added while the wax is in the molten state either as pure flakes or as a master batch in wax. The wax producer can benefit by the incorporation of an inhibitor in the manufacturing process to protect the wax against surface oxidation during storage and shipment.

TEST METHODS

The oxidation resistance of waxes and wax blends containing polyethylene was determined by a modification of the accelerated oxidation procedure of Morawetz (*1*). This test involved bubbling 1 liter per hour of dry oxygen through a fritted glass dispersion tube submerged in a 100-gram wax sample maintained at 300°F. The test was later modified by the addition of solid iron and copper catalysts. Copper and iron wire, each 3 ft. in length, no. 14 A.w.g., 0.064 in. in diameter providing a total surface area of 0.1448 sq. in. per gram of wax, were prepared in the form of coils and immersed in the wax above the outlet of the fritted glass bubbler. The performance of di-tertiary-butyl-para-cresol was also evaluated at 203°F. The degree of wax oxidation was followed by peroxide number, color, and odor determinations.

TEST RESULTS

Figure 1 charts the development of peroxides against hours of test at 300°F. for a 124–126°F. AMP paraffin wax, in the presence and absence of the solid iron-copper catalyst. Here the stability of the wax was increased tenfold by 0.01% of the inhibitor. The same type of paraffin wax was blended with

* DBPC is the Koppers Co., Inc., trade-mark for di-tertiary-butyl-para-cresol.

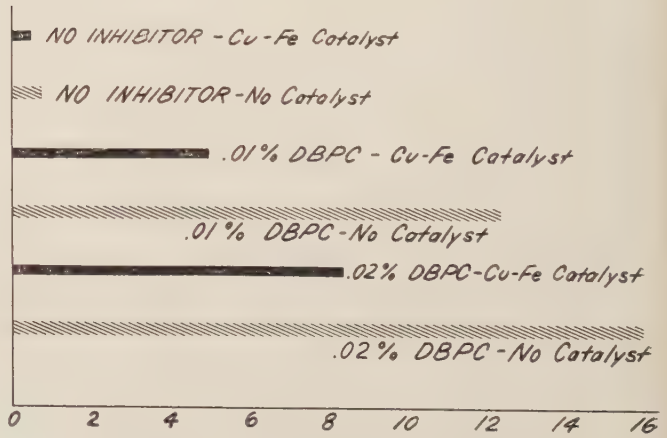


Fig. 1. Effect of DBPC inhibitor on paraffin wax

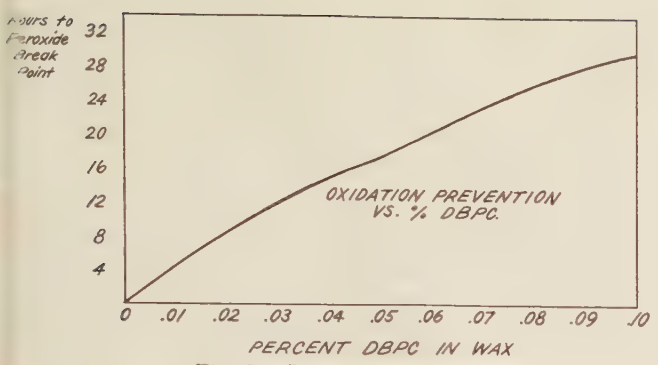


Fig. 2. Induction period

15% of polyethylene resin A having a molecular weight of 7000 and evaluated at 300°F. in the presence of catalyst. The higher concentration of polyethylene was used to accentuate any adverse effects of the polymer on inhibitor function. A fourteen-fold increase in stability was realized at 0.02% inhibitor concentration as illustrated in Fig. 2. In each case the use of the inhibitor at higher levels caused greater inhibition.

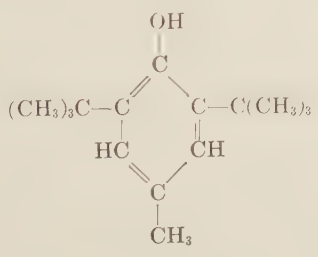
Samples of polyethylene modified waxes tested at 203°F. demonstrated longer life than the same blends tested at 300°F.; but, the relative inhibitor response at the two temperatures was identical, which illustrates that the effectiveness of di-tertiary-butyl-para-cresol is maintained at lower temperatures.

This inhibitor demonstrated exceptionally good color protection in the waxes and blends tested. Color development in the inhibited samples was effectively retarded during the test period.

Organoleptic tests indicated that "off odor" was detectable just prior to the rapid development of peroxides in the region near the sharp bend in the curves. Di-tertiary-butyl-para-cresol thus protected the wax or wax blend from poor odor to the same extent that peroxide formation was retarded.

Moureu and Dufraisse (*2*), early workers in this field, believed that antioxidants react with organic peroxides in a series of reactions in which the peroxides are decomposed and the antioxidant regenerated. Later researchers such as Alyea and Backstrom (*3*) postulated that antioxidants interrupt oxidative chain reactions as peroxide reactors and are themselves oxidized in the process. Morawetz (*1*) in this investigation of phenolic compounds as antioxidants for paraffin wax presents evidence showing that the alkyl phenol antioxidants such as di-tert-butyl-para-cresol perform their function by reaction with organic peroxides leading to the formation of dimer peroxides. More recently Campbell and Coppinger (*4*) postulate the role of the antioxidant to be twofold. First, it may prevent initiation of an oxidative chain reaction by reaction with free radicals in the system; secondly, it functions by inactivating the organic peroxide after it is formed. Wasson and Smith (*5*) suggest that di-tertiary-butyl-para-cresol oxidizes predominantly to an aldehyde type derivative which in itself has antioxidant properties.

Di-tertiary-butyl-para-cresol is a hindered phenol in which the two tertiary butyl groups mask the hydroxyl group so effectively that it does not manifest the physical and chemical activity typical of ordinary phenols. An expanded structural formula is shown below. Because of this chemical arrangement, it is not of toxic nature as are a number of other phenol derivatives. Considerable work has been carried out to study the toxicological properties of this inhibitor and tests are now in progress at the Albany Medical College to assist in securing approval of this inhibitor by the Food and Drug Administration. Sufficient information is available to indicate that di-tertiary-butyl-para-cresol has an extremely low order of acute toxicity for mice. From a practical standpoint, an antioxidant which possesses an LD_{50} (the quantity of the antioxidant which is fatal to 50% of the test animals following oral administration) of 1000 mg. per kg. or above has been stated by Food and Drug Administration representatives (*6*) to have met at least one important criterion of harmlessness. Di-tertiary-butyl-para-cresol has met this requirement and according to Lehman (*7*) has successfully passed the initial stages of the toxicological investigation.



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The Utilization of Ammonia-Base Sulphite Liquor

J. B. MARTIN

Manufacturers of pulp and paper have been aware for many years of potential profits being lost through their inability to utilize fully the lignin fraction of their logs. This portion and the sugars resulting from the pulping operation constitute about 50% by weight of the dry wood input to a mill. Sulphite mills customarily waste the nonfibrous extracts of wood into sewers. In the kraft and soda processes a small per-pound value for these chemicals is realized through their use as fuel. It is clear, however, that the noncellulosic pulping residues can yield maximum value only as chemicals of commerce.

The by-product chemicals of the sulphite pulping process are discharged from the digester in an approximate 10% concentration in water. The difficult and costly removal of the large quantity of water present has long been a barrier to their profitable use. Two methods, evaporation of the water and precipitations of the solids, have been studied by many workers.

During the evaporation of calcium-base liquor, the channels of heat exchangers tend to fill up with calcium scale. An ammonia-base cooking process has been studied to avoid this difficulty. The sulphite pulping operation at the Lebanon, Ore. mill of the Crown Zellerbach Corp. has been carried out for several years using an ammonia base. In addition, a sizable pilot plant has been put into operation at this mill for the evaporation and burning of the liquor. The availability of the 50% solids produced by the evaporator has made it possible to proceed with the marketing of the ammonia-

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base chemicals and derivatives. The trade name, Orzan, has been given to this general class of chemicals, either in liquid or solid form.

Ammonia-base sulphite liquor differs chemically from calcium base mainly as to its cation constituent and physically only as to its darker color. It consists essentially of ammonium lignin sulphonates, 50 to 60% and sugars, 25 to 30%. Its nitrogen content is approximately 3.5%. It may be utilized industrially in some of the established applications of calcium liquors. It finds use in many other applications where the ammonium ion makes a specific contribution.

Sulphite liquor by-products have an established market in the field of dispersants. The gypsum industry is using sizable quantities as a means of lowering viscosity or increasing solids in gypsum slurries for wall board manufacture. Large tonnages of asphalt emulsions for blacktop roads are prepared with lignin dispersants. The cement industry uses lignin dispersants to facilitate the grinding of raw materials in the production of portland cement. Wettable sulphite powder and pest control sprays are made with them. They are used to a minor extent as leveling agents in wool dyeing and paper coloring. They may find use as additives to soaps in industrial cleansers. The oil well drilling industry is beginning to use lignin dispersants in drilling muds.

Sulphite liquor by-products have useful adhesive properties. They are utilized as binders in the formation of coal, carbon and ore briquettes, foundry sand cores, and refractory ceramic bodies. They have been used as constituents of glues for spiral paper tubing and as the adhesives of remoistening tapes. Increasing interest is being shown in their application as a dust palliative for unpaved roads and playgrounds. Sizable quantities of sulphite liquor go into linoleum paste.

Most of the sugars in sulphite liquor are reducing in character. They will reduce copper sulphate to metallic copper under conditions of acidity and elevated temperatures. The sugars may also be fermented by yeast to produce animal feeds or alcohol.

Sulphite liquor by-products have been found satisfactory as partial substitutes for natural tannins in the tanning of certain leathers.

Chromic acid and the dichromate or chromate salts of potassium, sodium, and ammonia react with lignin sulphonates at room temperature to render them less water soluble. The extent of the effect obtained is controlled by the ratio of the chromic acid to lignin sulphonate. The rate of this exothermic reaction may be decreased by buffering the acidity of the solution. Mild reactions of solutions above 15% solids merely increase viscosity. Further reaction produces stiff gels. Still further reaction yields crumbly elastic solids retaining the original water. The dehydrated solids are brittle and of low order of strength. The incorporation of plasticizers tends to maintain the elastic character of the solids.

The only application of this reaction known to us is the "chrome-lignin" process for solidification of soil as developed by Smith and Hough of Cornell University. They found that a wide variety of soils could be put into solid form by briquetting with chromium-treated sulphite liquor as a binder. The synthetic gravel so produced did not disintegrate after 6 months' submersion in water. It withstood freezing, thawing, and the stress of dropping from a 3-story height. The men who developed this process believe that with fine-grained soils, polynuclear coordination complexes form between the oxygens of the soil particles and the oxygens of the lignins with oxygen bridges linked through chromium atoms.

There are a number of applications of Orzan which are in part or entirely dependent on the presence of its 3.5% nitrogen in the form of ammonium ions. Chief among these is its use in agriculture. When Orzan is added to soil, the lignins eventually raise the level of stable soil organic matter. Biological action reduces them to humus with resulting improvement in soil physical properties. The sugars are used as readily available food by soil bacteria which are thereby increased in activity and population. It has been shown that soil organisms require in their diet about $1\frac{1}{2}$ parts of nitrogen for each 100 parts of organic matter decomposed. From this it is apparent that Orzan has an excess of about 2% nitrogen available for direct plant stimulation. In addition, it contains 6% sulphite and all of the trace elements which occur in the growing tree. Preliminary growing tests have shown that the nitrogen and sulphur are in forms readily changed in soil to compounds usable by plants. There is also evidence that Orzan may increase the water holding tendency of soils.

An intensive research program on the agricultural value of Orzan is being carried out at Oregon State College in Corvallis, Ore. An evaluation is being made of its plant growth stimulation, its effect on soil organisms, and its influence on soil structure and chemistry. In addition, many commercial growers in the Northwest are extending practical knowledge with field trials.

In the use of Orzan as a dispersant the freedom from calcium ions is a distinct advantage. In dispersing carbon black or asphalt it may be added in alkaline solution to fatty or resinous soaps without deleterious precipitation. By this means quick-set asphalt emulsions can be converted into the penetrating type with slow set.

The experience of others has established that sulphite liquors, to be of maximum value to the tanning industry, must be free of calcium.

The presence of the ammonium ions accounts for an important reaction not possible with other sulphite residues. Under the influence of elevated temperatures, the ammonia, the lignin sulphonates, and the sugars condense to large molecular structures with different characteristics. The most obvious indication of change is the increasing insolubility of the ingredients in water.

The condensation may occur with the chemicals either in solution or in dry form. The rate of reaction increases markedly with increasing temperatures. Condensation is more rapid if a small amount of water is present initially than if the chemicals are first dried. The course of the condensation is evidenced in solutions by increasing viscosity, and proceeds, in closed vessels, to a stiff gel containing the original water.

A variety of products may be obtained by the heat treatment of dry Orzan. In the early stages they remain soluble. With further heating, an increasing proportion of the solids remain undissolved when placed in water but swell to a flatulent gel. At a further stage virtually none of the solids will dissolve in water but all will swell and soften. At the final stage of heating, the solids are insensitive to water. It is anticipated that many applications will be found for heat-treated Orzan. Insoluble but swellable powders may find use in plugging porous strata during oil well drilling. The same product may be satisfactory as a conditioner for mixed chemical fertilizers to prevent caking, or as a direct additive to certain soils to loosen them and improve water retention. The insoluble, insensitive form might be developed into a low-cost ion exchange resin. It may also perform the same function as walnut flour in a plywood glue line at a lower cost.

The Industrial Products Div. of Crown Zellerbach Corp. is making ammonia-base solids and derivatives available commercially in four forms:

1. Orzan A—a powdered solid, 6% water, with acid reaction.
2. Orzan AL-45—45% solids solution, slightly acid.
3. Orzan S—a powdered sodium-base solid, 6% water, slightly alkaline.
4. Orzan SL-45—a 45% sodium-base solids solution, slightly alkaline.

Orzan AL-45 is a partially neutralized product of the evaporation of the ammonia-base sulphite liquor at Lebanon, Ore. Orzan A is produced by spray-drying the acidic concentrate.

PRESENTED at the Tri-Association meeting, Victoria, B. C., Sept. 27, 1952.

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NATIONAL MEETINGS

Second Conference on Application of Statistical Methods in the Pulp and Paper Industry, Western Michigan College, Kalamazoo, Mich., June 15–26, 1953.

Plastics Conference, New York State College of Forestry, Syracuse, N. Y., September 15–16, 1953.

Tenth Fibrous Agricultural Residues Conference, Trenton, Ontario, October 8–9, 1953.

Third Corrugated Containers Conference, Statler Hotel, New York, N. Y., October 15–16, 1953.

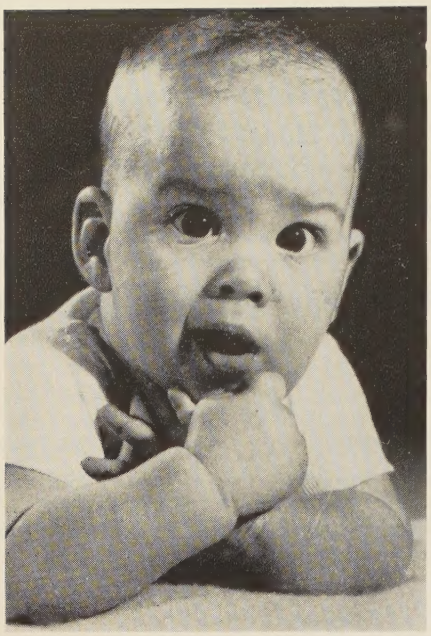
Eighth Engineering Conference, Sheraton-Mt. Royal Hotel, Montreal, P. Q., October 26–29, 1953.

Seventh Alkaline Pulping Conference, Rice Hotel, Houston, Texas, November 18–20, 1953.

Thirty-ninth Annual Meeting, Commodore Hotel, New York, N. Y., February 15–18, 1954.

NEW ENGLAND SECTION AND MAINE-NEW HAMPSHIRE SECTION:

Poland Spring House, Poland Spring, Maine, June 19–20, 1953.



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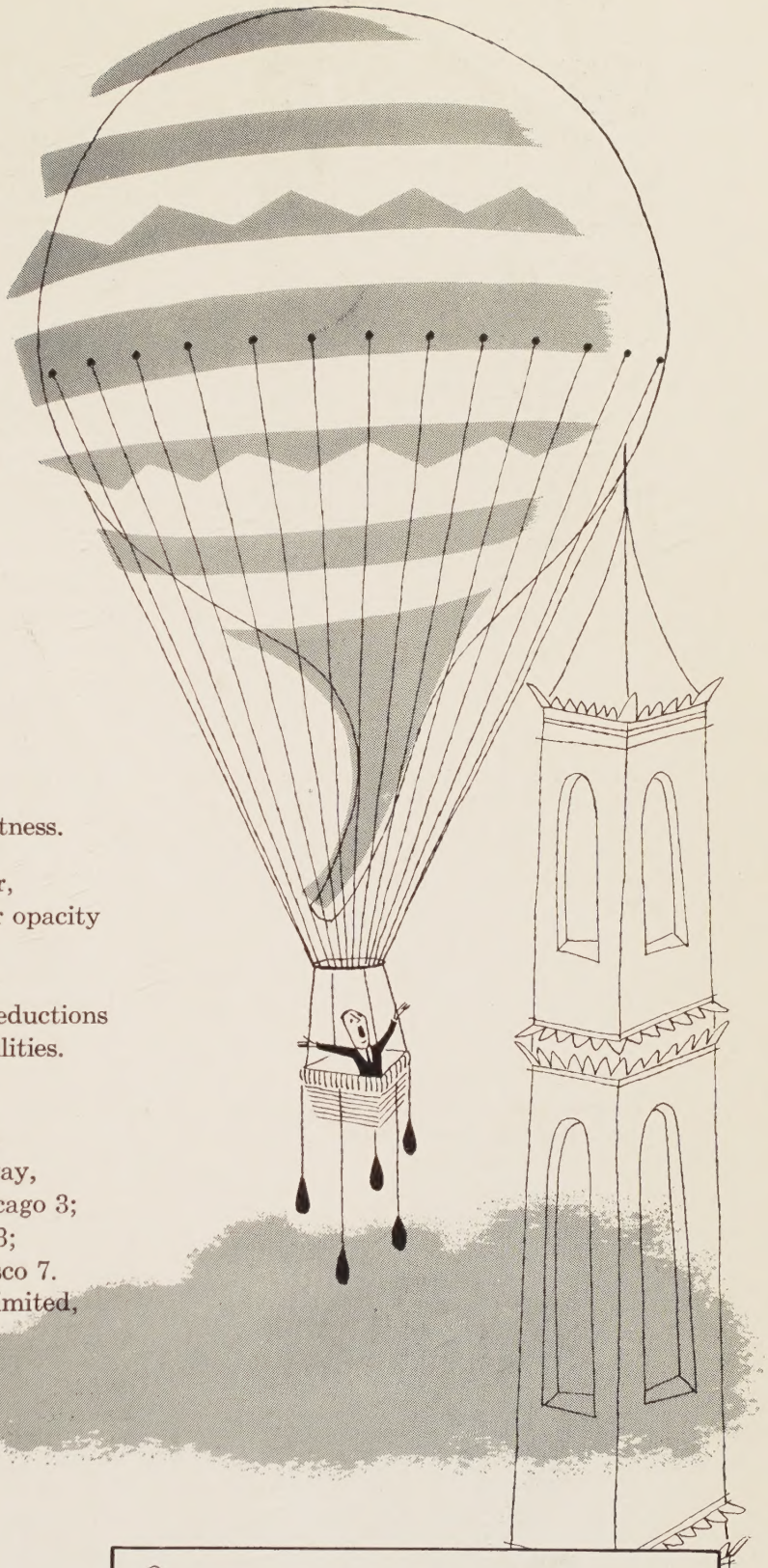

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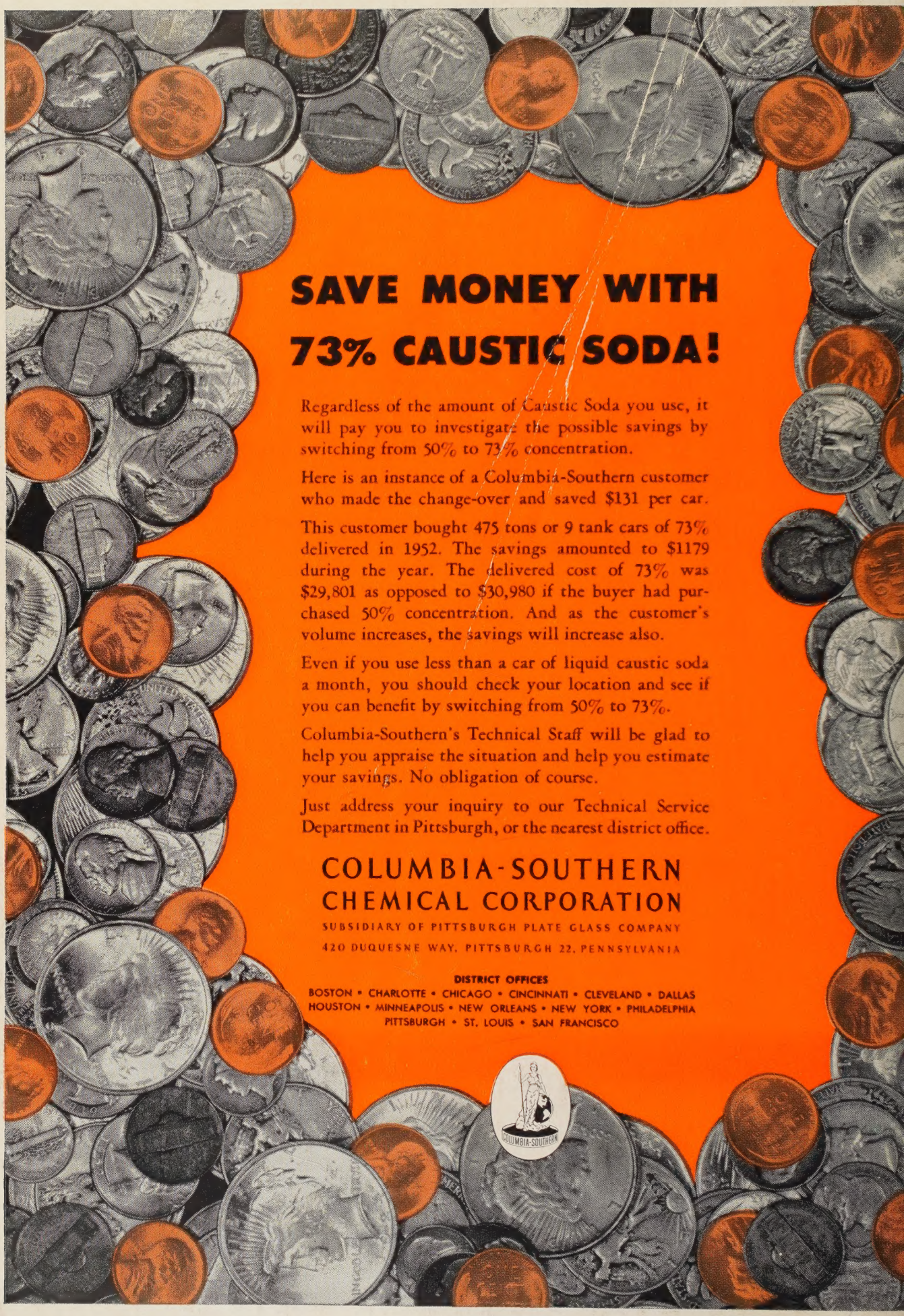

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